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William W. Hurlbut, President, 1936–1937

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HISTORY OF THE DEVELOPMENT OF THE USE OF WATER IN NORTHEASTERN NEW JERSEY[1]

By Charles H. Capen, Jr.

(Engineer, North Jersey District Water Supply Commission, Newark, N. J.)

While public water supplies in New Jersey have assumed a position of importance only in the last hundred years or less, it is nevertheless necessary, in tracing their development and the underlying causes, to turn back the pages of history for a period of nearly two hundred years. In colonial days, the streams were chiefly of value because of their use for power and transporation, but since these uses had an important bearing on later events, a brief history of the early days is of interest.

EARLY USES OF WATER

The first important event was the use of the Passaic River at Little Falls for power purposes by Cornelius Board, a Welshman, about 1730. After having operated a mill there for only a short time, he learned from the Indians of the existence of iron ores to the north and thereafter turned his attention to the production of iron in what is now the northern part of Passaic County. In all of these early

[1]From paper read at meeting of New Jersey Water Works Association, Asbury Park, N. J., November 14, 1935.

industrial enterprises, water power was of prime importance. It drove the mills for grinding wheat, cutting lumber, supplying forced drafts for blast furnaces and driving the hammers at the forges for shaping the metal drawn from the furnaces.

Not long afterward the extensive water power possibilities of water power at Boonton were recognized and the existence of iron ores in the vicinity led to the erection of iron mills at that location. An interesting anecdote is told about this mill in connection with the reported manufacture of "blister steel." This article was supposed to be made only in England and its production in the colonies was forbidden. The provincial Governor of New Jersey was ordered by the King to investigate the rumor that it was being made at Boonton. Having a financial interest in the mill, the Governor was not inclined to be too observing and after having been sumptuously dined and wined before making his tour of inspection, he did not notice that no effort was made to show him the cellar of the building where blister steel was being produced. He then reported that the rumor was unfounded.

The development of water power for use in the iron industry took another long step forward when Peter Hasenclever (sometimes called Hausenclavin), a German iron producer, came to this country in 1764 under the employ of an English Company and started operations in a large part of Passaic and Morris Counties. He created several ponds for the use of water power to operate blast furnaces and forges, including Long Pond (now Greenwood Lake) Forge Pond (now part of the Wanaque Reservoir) and Echo Lake, Charlotteburg Pond and other lesser bodies of water now included in the Newark water supply.

That brilliant financier, Alexander Hamilton, was responsible for the next important step when he brought about the creation of the Society for the Establishment of Useful Manufactures at the Great Falls in Paterson in about 1790. This Company obtained extensive rights to the flow of the Passaic River and has played an important part in the industrial development of Paterson during all the intervening years.

Judge Martin Ryerson, in 1807, acquired the extensive holdings originally started by Hasenclever and succeeded in building up the iron industry into one of the largest business enterprises in New Jersey.

MORRIS CANAL AND WATER POWER

The first important use of water in this area for other purposes than manufacture, occurred when the Morris Canal and Banking Company, organized in 1824 by a Dutch Company, started construction work in 1827 and opened the Canal to traffic in 1830. This Company acquired large grants of water rights throughout the northern part of the State and developed what is now Lake Hopatcong as a main source of water supply for the Canal.

Shortly thereafter, in 1832, Jacob M. Ryerson, a son of Judge Ryerson, appreciating the value of water power and having been elected to the State Senate in 1831, was instrumental in obtaining a Charter for the industrial use of water from the lower Passaic River. The Dundee Dam came into prominence as a result.

The immediate popularity of the Morris Canal led to a shortage of water for transportation purposes. After some study, the Canal Company negotiated with Jacob M. Ryerson and his brother, Peter M. Ryerson, for the development of Greenwood Lake, the necessary transfer of property and rights taking place in 1837. A new dam was built, greatly enlarging both the area and capacity of Long Pond but reserving to Ryerson the now famous right to the continuous use of sufficient water from the Lake to operate "a forge with two fires and a saw-mill with one saw." Curiously enough, the Canal Company did not acquire the right to flood all the land covered with water and it was not until 1855 that a law was passed by the State of New York giving the Company the right to acquire lands so flooded, even though the actual flooding had occurred twenty years before.[2]

The panic of 1837 ultimately brought financial disaster to both the Canal Company and the two Ryersons. The property of the former was purchased by influential men in New Jersey in 1844 while the holdings of the latter were eventually purchased by Abram S. Hewitt. The Canal Company was re-organized in 1848 and in 1871 was taken over by the Lehigh Valley Railroad. In its life of nearly 100 years the Canal showed a profit in only two or three years. Under the strong management of Hewitt, however, the iron industry and other allied interests flourished and the large holdings of the Ringwood Company of today are the outgrowth of his enterprise and his ability

[2] Greenwood Lake lies in two states.

to keep together much of the property originally assembled by Hasenclever.

FIRST LARGE WATER SUPPLIES

With the control of water rights of the Passaic River above the Dundee Dam held in private hands, it was necessary for municipalities to look for a source downstream. Jersey City obtained permission to erect a pumping station on the east shore of the Passaic River just above Kearny in 1852 and started delivering water in 1854.

The Passaic Water Company was formed at about this same time and having made arrangements with other private interests, started to deliver water from below the Great Falls in 1856. The intake was changed to a point above the Falls in 1867.

Newark had also been negotiating for an adequate supply and in 1870 established a pumping station on the west shore of the Passaic River in Belleville.

The two lower sources were the cause of much complaint and dissatisfaction as to quality but the first important step toward a change was taken when Newark, in 1879, retained Croes and Howell, eminent water engineers of that period, to report on the best future source of supply. The importance of the water rights of private interests was fully recognized and a study was made of the possibilities of the Pequannock, Wanaque and Ramapo Rivers. The report recommended the use of the first but gave consideration to the advisability of later developing the other two.

FIRST STATE COMMISSION

Public sentiment had been greatly aroused by this time and resulted in 1882 in the creation of the first State Water Supply Commission whose duties included the study of coöperative methods of developing water supplies for groups of muncipalities. In 1884 its appropriations were discontinued.

LATER DEVELOPMENTS BY CITIES

In 1889 the City of Newark entered into a contract with the East Jersey Water Company, which had obtained water rights from the Lehigh Valley Railroad, for the development of the Pequannock Supply. Later (1900) the City exercised the right to purchase the entire supply.

Many of the events of the last quarter of the nineteenth century were influenced by the studies of the State Geological Survey, culminating in the detailed Report on Water Supplies in 1894.

With control of the Passaic River for water supply purposes still resting in its hands, the East Jersey Water Company, having merged its interests with those of the Passaic Water Company and other affiliated companies, started building the supply works and filtration plant at Little Falls. Water from this source replaced that from Great Falls just before the close of the century, but the entire works were not completed until 1904.

About this same time, the importance of maintaining the quality of water for domestic purposes was given adequate recognition by the passage of the Potable Water Act in 1899, giving jurisdiction over the quality of all waters used for potable purposes to the State Board of Health (now the State Department of Health).

Meanwhile, Jersey City had also become dissatisfied with the quality of water from the lower Passaic River and finally in 1899, entered into a contract for a supply of water from the Rockaway River. After much litigation with the private interests that developed the supply, the City finally acquired it outright in 1910.

PASSAIC RIVER FLOODS

The flood of the Passaic River in 1902, followed by the still greater one in 1903, gave rise to the creation of the North New Jersey Flood Commission of 1903 and the Passaic River Flood District Commission of 1906. Almost simultaneously the same matter was studied and reported on by the State Geological Survey.

SECOND STATE WATER SUPPLY COMMISSION

By this time the value of control of water supplies by the State had gained still greater prominence and in 1907 the second State Water Supply Commission was formed. This body had jurisdiction over the diversion of all water, the investigation of all public water supplies and the power to tax divertors for all water used in excess of 100 gallons per capita per day (as based on the 1905 census) at the rate of not less than $1 nor more than $10 per million gallons. After turning down applications from both Newark and Paterson for permission to develop the Wanaque Supply, the Commission promoted a movement for the ultimate use of the Wanaque by a number of interested municipalities. The first real test of its powers came when it was

ruled that such major expenditures should be voted on in a referendum. The purchase of the extensive Wharton Tract on the Mullica River in southern New Jersey was accordingly submitted to the voters in 1915 and was rejected by them. Practically the entire powers of the Commission were thereafter (1916) merged with the Department of Conservation and Development.

WANAQUE SUPPLY

The efforts of the State Water Supply Commission having, to a large extent, failed to attain its most important goal, those interested in developing the Wanaque Supply were instrumental, early in 1916, in the passage of an Act creating two District Water Supply Commissions although the one in North Jersey is the only one so authorized that has functioned. Under this Act, Newark and Paterson petitioned for the appointment of the North Jersey District Water Supply Commission and in the same year authority was granted to the newly formed body by the Department of Conservation and and Development for the right to divert 50 million gallons per day from the Wanaque River. Later (1924) the right was increased to include the full flow of the stream as well as Post Brook, except for minimum compensation water requirements. As a result of these activities the Wanaque Supply was formally placed in operation on March 20, 1930, after having been considered as a source of supply for more than 50 years.

RAMAPO CASE

In 1921 the City of Bayonne sought permission to develop the Ramapo River for its own needs. This permit was granted by the Department of Conservation and Development but was later set aside by the Court of Errors and Appeals.

POST WAR DEVELOPMENTS

During the period from 1921 to 1924, the steady increase in the use of water led to many studies for future requirements.

In 1922 the Department of Conservation and Development retained engineers to make a study of future needs and to recommend future developments. This study was State wide in scope. It was recognized that the Metropolitan Area of northeastern New Jersey was the principal market for future water and finally the Long Hill

Project was recommended. This received vigorous opposition from contiguous municipalities.

Shortly thereafter the City of Elizabeth seeking to be relieved of private ownership of its water supply, had a report made on a new supply at Stony Brook and had a valuation made of the properties of the Elizabethtown Water Company with a view to the ultimate purchase of the part of the system that it used. (This purchase was consummated on July 15, 1931.)

In view of its position as the only body with definite powers to assist in the joint development of supplies, the North Jersey District Water Supply Commission studied the problem and in 1924 reported in favor of a supply known as the Chimney Rock Project. The time, however, was not quite ripe for this development.

Having arranged to become participants in the Wanaque Supply, the three Cities of Paterson, Passaic and Clifton, in 1925, had an appraisal made of the property of the Passaic Consolidated Water Company (successor to the old East Jersey Water Company and its associates). The condemnation of the system ensued and the purchase was finally consummated on October 24, 1930, the active agent for the Cities being the Passaic Valley Water Commission, formed in 1928 under an Act of 1923 authorizing such bodies. Thus the private water supply rights of the Passaic River finally passed into public ownership.

Although the Long Hill Project seemed to be rather definitely discarded, the State Legislature in 1925, authorized a study to be made by a Water Policy Commission to report on the entire subject, including the advisability of the approval of the Tri-State Treaty between New York, New Jersey and Pennsylvania in regard to the use of waters of the Delaware River. This Treaty had been under active consideration for two or three years. The report, issued in 1926, recommended certain changes in the Treaty before it should be accepted by New Jersey and favored continuation of the powers of both the Department of Conservation and Development and the North Jersey District Water Supply Commission.

Sentiment in Bergen County caused the creation of Bergen County Water Commission in 1928 and a report prepared for that body by the North Jersey District Water Supply Commission advocated the ultimate development of the upper reaches of the Ramapo River for the water needs of Bergen County.

In 1929 the State Water Policy Commission was created to take

over the water functions of the Department of Conservation and Development and to formulate a definite plan for future supplies. The overlapping powers formerly existing between the North Jersey District Water Supply Commission and the Department of Conservation and Development were somewhat clarified. The State Water Policy Commission reported in favor of a high level supply and later advocated the Bunnvale Project. A fund of seven million dollars was approved in a referendum in 1930 for the purpose of purchasing land for future developments but in a subsequent referendum was diverted for other purposes.

About the same time the cities of Newark, Bayonne, Elizabeth and East Orange, requested the North Jersey District Water Supply Commission to report to them on a future supply of water. This report, issued in 1930, again recommended the Chimney Rock Development as a Second Major Project.

In May 1929, the New York Water Power and Control Commission approved the plan submitted by the City of New York for the development of a supply from the Delaware River. Action to restrain the City of New York from making this diversion was brought before the United States Supreme Court by the State of New Jersey, with the State of Pennsylvania as an intervenor. The decree of the Supreme Court, rendered May 4, 1931, allowed New York to divert 440 million gallons of water per day from the Delaware River Watershed with certain provisions as to maintaining the flow of the river during low flows.

Effects of the depression caused a cessation in development activities but under the impetus received from the proposed granting of large Federal sums for self-liquidating projects, a bill was introduced in the Legislature in 1934 for the purpose of creating a Water Authority. This proposed the taking over of the functions of the State Water Policy Commission and the North Jersey District Water Supply Commission. With the Wanaque Supply as a nucleus, it suggested the development of water supplies for the State at large. Early in 1934, Governor Moore sent a special message to the legislature recommending this type of procedure but the Act did not pass. A special report to the Governor by the State Water Policy Commission in December 1934, recommended the creation of a Water Authority and prescribed its principal functions.

Governor Hoffman has also stated his views in favor of a centralization of the control of water supplies and an Act was introduced in the Legislature early in 1935 but failed to pass.

EXISTING AGENCIES

Considerable confusion naturally exists among those not actively associated with water supply matters as to the status and functions of the various bodies having jurisdiction over water supplies. For that reason the following list of actively functioning entities created as a result of State Legislation, is given, in the order of formation, together with their principal duties in respect to water supply.

State Department of Health: has approval of potability of all public supplies and supervision of their operation, as well as authority to prevent pollution of all streams.

Board of Public Utility Commissioners: fixes rates of all private water companies and requires an annual report of financial transactions and physical assets from all water supplies both public and private.

North Jersey District Water Supply Commission: controls and operates the Wanaque Supply for eight participating municipalities and their customers.

Passaic Valley Water Commission: operates water supply system of the three Cities of Paterson, Passaic and Clifton and their customers.

State Water Policy Commission: has approval of all diversion of water, stream control and encroachments, and collection of excess diversion tax.

FUTURE PROBLEMS

Past experience has indicated that the trend in the development of future water supplies is toward the use of areas in the relatively sparsely settled uplands. This movement may become even more marked as time goes on, for the reasons that good roads and rapid transportation, as well as the availability of modern conveniences in practically any locality, are rapidly tending to decentralize population and stimulate growth in suburban and rural areas. Thus available territory near centers of population, on which water supplies can be developed, is rapidly diminishing and areas further away must be sought. This trend has been frequently pointed out in past reports and cannot be emphasized too strongly.

The water requirements of the large centers of population are moderately well taken care of for the present, but a resumption of normal industrial activity may easily change the picture in a rela-

tively short time. The problem of administering the needs of a rather congested area, supplied by nearly 40 separate sources of water, has been studied by many different bodies and remains just as complex as ever. That it is not a new topic is evidenced by the fact that it has been discussed by every Governor of the State for the past fifteen years and has been the subject of many attempts at legislation. Whether the public interests will best be served by present bodies or by the creation of a new one is still the subject of of wide differences of opinion. The predominant control of water rights by private interests no longer exists and whatever may be the outcome, it seems certain that those vitally interested will have a definite voice in the shaping of the future course that is to be pursued.

EFFICIENCY IN WATER PLANT PUMPING STATION OPERATION

By Harry G. Coughlen, Jr.

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"Efficiency" is a much overworked word. It has more than one meaning; at least it brings different thoughts to the minds of different persons. Webster's Collegiate dictionary gives the following two definitions: (1) Quality or degree of being efficient, and (2) The ratio of the energy, or work, that is got out of a machine to the energy put in. Considering further the first definition, efficiency is the "quality or degree of being efficient." We find further that Webster defines the word "efficient" as follows: (1) serving as, or characteristic of, the working or moving part, operant, and (2) characterized by energetic or useful activity.

Having thus consulted the dictionary, we may now select those definitions which are peculiarly suited to the subject of this paper, and see wherein they apply to the operation of a pumping station.

Combining the foregoing definitions, we may produce the following as being especially applicable to the subject of pumping station efficiency: (1) supplying energetic or useful activity, and (2) quality or degree of being operant, or in the simple language of the power plant engineer, ratio of output to input.

This writer has been impressed by a rather peculiar fact determined by a close scrutiny of the Journal of the American Water Works Association for many years back. Those Journals include in their pages many articles concerning the selection of the proper equipment for a water works pumping station, but very few articles regarding the proper efficient and economical operation of a pumping station already built and in operation. It is the latter problem with which most pumping station operators are concerned, and about which we are principally concerned here today. However, since it may be that some of my listeners are contemplating the construction of additions or extensions to their pumping stations, it is well that we consider briefly the selection of the proper equipment, insofar as pumping capacity is concerned.

SELECTION OF EQUIPMENT

Before selection of necessary equipment can be accomplished, it is necessary that certain facts regarding demand and load must be obtained. In Indianapolis, the Engineering Department of the Indianapolis Water Company have developed rather exhaustive studies of what they have called "The Ultimate Development" of our several stations. In these studies, they have gone deeply into such questions as past, present, and probable future loads and demands, pumping and steam generation equipment needed to meet these demands, and all related subjects. They have proved very helpful in the past ten years in the installation of new equipment and have provided a comprehensive plan for the developments and extensions already completed and contemplated for the future.

What has been done in Indianapolis can be done elsewhere. If your company does not have an engineering department, then the work will most likely fall upon the shoulders of the pumping station superintendent or chief engineer. No water company, or department is so small that such a study and plan will not prove very helpful.

In preparing such a study, it is a simple matter to determine the demands to be anticipated from your domestic, commercial, and industrial consumers, but there is another item to be considered, and that is the very important problem of fire protection service. The question arises as to what should be anticipated in the way of fire fighting demands. If you are faced with such a problem, and every waterworks should consider itself always to be confronting such a problem, you can hardly do better than to use as your guide the recommendations of the National Board of Fire Underwriters. No doubt most of you are at least to some extent familiar with these recommendations, but I shall state briefly of what they consist in regard to pumping station capacity.

In brief, where extensive high-level storage of water is not available, the standard requirement of the National Board of Fire Underwriters is that, "Pumping capacity must be such, with the two largest pumps out of service, as to maintain maximum consumption and fire flow at required pressure." In regard to boiler capacity, for the steam operated pumping station, the requirements state that "Normally, there must be sufficient boiler capacity kept under at least one-half required steam pressure, to deliver full requirements, in connection with storage for a period of two hours." Similar

requirements are set forth for reserve capacity for hydraulic, electric, and internal combustion engine equipped pumping stations.

There is an article by F. G. Cunningham, of Fuller and McClintock, engineers, in the August, 1928 issue of The Journal under the title "Selection of Pumps to Fit Service Conditions." In this article, Mr. Cunningham says, in regard to underwriters requirements, that "although few stations are capable of meeting this severe criterion, there is no doubt that maximum capacity should be met with at least the largest single unit out of service." But, some of you may say, to conform with these requirements would mean the installation of much new or additional equipment in our plant, and the taxpayers, or the stockholders, as the case may be, would not stand for it. Perhaps such an attitude does exist in your community, but if so it behooves you, as one entrusted with the responsibility of maintaining required service at all times, to confront such opposition with an educational campaign which will finally result in gaining for you the support you need.

Mr. George H. Fenkell, in an article in the September, 1928 issue of The Journal entitled "The Management of Water Business" says, "The management of a water plant is confronted with the engineering problem of furnishing an abundant supply of water for domestic, commercial, and manufacturing purposes. To meet the requirements of each class of customers, it is necessary—that the quantity available at every point be sufficient for ordinary as well as for fire prevention purposes." Mr. Fenkell says further, in the same article, that "A well operated water plant is a great asset to a community for a number of reasons that are apparent and which should be appreciated by the consumers. Its effect in accomplishing a reduction in fire insurance rates, or in maintaining low rates already established, is at present generally intangible.—Excepting those that have given the subject careful attention, few realize to what an extent the demand for fire protection service influences the design and cost of the waterworks system."

If education on this subject is needed in your community, it should be along the line of economics. It has been this writer's observation that the average citizen has very little understanding of the part played by the local waterworks in fighting fires. When the siren sounds, or the bell rings, every one rushes to his door or to the street to "see the fire engines go by," and when the fire department

arrives at the scene of action and commences directing water from their hose nozzles onto the fire, many people will remark, "well, the fire department surely deserves a lot of credit for getting that fire under control so quickly." But how often have you heard anyone expressing appreciation of the fact that, the hose having been connected and the hydrant turned on, water actually did come from the nozzle at sufficient pressure and in sufficient quantities to make possible the effective control of the fire? This speaker does not wish to detract one whit from the praise and glory accorded our modern fire departments. They are, as a whole, splendid and efficient organizations, well manned, well trained, and well equipped; but the fact remains that without the support of the waterworks, they would not be very effective at many fires.

It is a strange fact that in the table of penalty points of the National Board of Fire Underwriters, there are more penalties assessable against the waterworks than against the fire department. This fact is reflected in the influence of the efficiency of the waterworks on fire insurance rates. Generally speaking, it may be said that, other factors being as they should, the greater the efficiency of the local waterworks, the lower will be the insurance rates. Herein lies the answer to the arguments of those opposed to compliance with the underwriters recommendations in regard to pumping station capacity. The saving in fire insurance rates, effected by compliance with these recommendations, and realized by every property owner investing in fire insurance, must be weighed against the cost as borne by the taxpayers or the customers of the waterworks and when such savings are found to be appreciably less than the cost, then, and only then, can the advisability of full compliance with the Underwriters recommendations be questioned.

Even though the savings may not quite equal the cost, there is another, less tangible reason for such compliance which for want of a better term, this writer calls the moral obligation. In an article by W. L. Eisert, chief engineer of the Northeastern Water and Electric Service, at Lemoyne, Pa., appearing in the October, 1935 issue of the magazine "Water Works Engineering;" he says, in part, "No company, whether financed by taxpayers or by bondholders is private property, and as operators, we can at best be but trustees of a public service, and the fullest development of that service is our entire task. To classify companies as private or municipal is fallacious, for in the final analysis of a successful company, irrespective of actual owner-

ship, it is primarily operated by and for the consumers it serves." We as operators should all recognize and admit the truth of these words. It is the fulfilment of that "public trust" that places upon us all the responsibility for permitting nothing to stand in our way of having our pumping stations so equipped as always to be able to meet all demands placed upon it with "an abundant supply of water at the required pressure," whether it be to provide the child a drink, or to furnish the means of preventing serious conflagration.

So much for the first part of our definition, that is "supplying energetic or useful activity."

OPERATION

Let us consider now the second phase of the efficient operation of a pumping station, or the quality or degree of being operant. This speaker is aware that his listeners as a whole are not interested in a lot of detailed figures as to exact percent efficiency, but are probably interested to know what steps or actions are necessary from day to day and week to week to assure that a pumping station may always be ready, at a moments notice, to meet whatever demands are placed upon it by the consumers, and to meet that demand at the lowest possible cost. Such service as just mentioned should be and probably is the constant aim of every pumping station superintendent or chief engineer, but how many of us are fully aware of the many things that enter into conformance with such a policy: First, and perhaps most important of all, is the problem of maintenance of the plant; and by maintenance I mean simply the necessary repairs and adjustments that must frequently be made to the equipment and buildings. Quoting again from the article by Mr. Eisert in Water Works Engineering, he says

> "Failure to maintain property is a shortsighted and intrinsically dishonest policy, inevitable of failure, and in the course of time supremely expensive. Disbursements to maintain plant and equipment at the highest operating efficiency are a paramount duty of operation."

It matters not whether the plant be powered by steam, electricity, water, or internal combustion engines, the fact remains that a certain amount of inspection, adjustment, and repairing is constantly needed in some part or parts of the plant to guard against possible failure at a time of peak demand. Particularly is this true in the plant which does not have installed the reserve capacity discussed in preceding paragraphs.

One very important feature of successful maintenance of a plant is regularity of inspection. The maintenance foreman, or engineer in charge, should prepare a schedule for the regular inspection of each and every unit in the plant. The frequency of inspection of the various units will vary of course with the different types, and with the normal frequency or regularity of operation, so that no hard and fast rule may be stated. It remains for each plant to set up its own schedule, based upon experience, and to revise that schedule from time to time as conditions warrant. Certain items of maintenance will be found to depend upon hours of use, others upon elapsed time, gallons of water pumped, total pounds of steam generated, or some other factor, but the essential feature of the whole scheme is regularity. Adoption of a properly prepared inspection schedule, closely adhered to, will in most cases result in the discovery of needed repairs and adjustments before they become serious, and will permit advance scheduling of repairs so that full advantage may be had from normal periods of light demand, or seasonal fluctuations in load.

There comes a time in the operation of any piece of mechanical equipment when the question arises as to whether or not it is advisable to spend money on repairs or to invest in new equipment. Pumping and power generation equipment, like everything else, become obsolete with the passage of years, and while they may be maintained at or near their original conditions, new equipment might be of sufficiently greater efficiency to justify the retirement of the old and installation of new equipment. However, that is not the object of this paper; so let us pass on to other fields of thought on the efficient operation of a pumping station.

How car we be sure that the various units, or the pumping station as a whole, are operating as efficiently as it is possible for them to be operated? The word "efficiently" is here used in the sense of getting out of the equipment, at the lowest possible cost, the greatest possible return in relation to the energy supplied. The writer is referring now, and will continue throughout the remainder of this paper to refer, to the operation of a steam operated pumping station, using coal as fuel. While not all pumping stations are of that type, probably most of them are. At any rate, it is in such a plant that there will be found the greatest possibility of improvement, and the principles therein applied may also be applied, with suitable variations, in plants of different types of power or of fuel.

Plant load factor

There is one factor vitally affecting the efficiency of every pumping station. That is the plant load factor under which a pumping station is compelled, or permitted to operate. There are two general classifications into which all pumping stations may be divided. One classification is that wherein the station pumps into elevated storage reservoirs, from which in turn the water flows by gravity to the distribution system and thence to the consumers. Pumping stations in this group find themselves confronted with the relatively simple problem of pumping a uniform supply of water to the reservoirs, a situation which makes possible, in most instances, the operation of the station at its most efficient pumping rates.

The other classification is that wherein little or no elevated storage is provided, and the pumping station discharges directly into the mains of the distribution system. This condition does not permit the operation of the plant at its most efficient pumping rate at all times. On the contrary, a pump, or group of pumps, must always be in operation which can carry the load of the moment and still have a reserve capacity sufficient to carry the sudden increased demands placed upon the system in case of fire, and indeed not only fires, but suddenly increased demands for domestic, commercial, and industrial uses. Fortunately, these latter increases can in most cases be anticipated by the engineer on duty, and in most cases he is well prepared, but he can not predict when, or to what extent he will be called upon to meet the demands for fire protection. It is for this reason that the engineer in charge must at times knowingly operate a unit at a rate which is not the most economical.

Then too, in the steam plant, there is the problem of boiler operation. Just as the pumps in service must at all times have a reserve capacity for suddenly increased demands, so also must a corresponding reserve capacity be available at all times in the boiler room. In fact, it is even more important in the boiler room, for while in most cases, another pump can be put in service and take over part or all of the increased load in a few minutes, such is not true of a cold boiler. It takes a long time to start a fire in the furnace and raise full operating pressure in a boiler, so long, in fact, that in most instances the emergency would be past before full pressure could be attained. It is necessary therefor to carry sufficient boiler capacity in bank to assure a constant supply of steam to the engine room at all

times. In spite of constant vigilance and frequent inspections, there will be times when, without warning, some condition will arise to necessitate taking a boiler out of service for a short period, and it is imperative that there be a reserve capacity in bank at all times. This, of course, reduces the efficiency of the operation of the station as a whole, but it is a loss which must be accepted and charged to the necessity of maintaining service at all times. The waterworks engineer in the group under consideration, pumping directly into the mains, cannot allow his pumps to stop even for a minute for, without the aid of elevated storage, a few minutes shut down might cause an interruption of service that would be disastrous, not only to the waterworks, but perhaps even to the entire city.

There are many steps between the delivery to the pumping station of energy in the form of coal, or other fuel, and the delivery by the pumping station to the distribution system of a constant supply of water in sufficient quantities and at sufficient pressure to meet the demands of the consumers. It is the ratio of these two quantities that meets the definition of efficiency given in the introduction of this paper, that is, "the ratio of energy, or work, that is got out of a machine—to the energy put in." The result of this ratio can be calculated, with the aid of certain instruments and measurements, to produce a figure which can well be called station duty, and which will serve as an indicator of the overall efficiency of the pumping station. However, between these two end points, there are certain other steps which can and should be checked frequently, as further and more detailed studies of the operating efficiency of the plant.

DAILY LOG DATA

The successful accomplishment of such efficiency studies requires primarily the acquisition and recording of certain items of information in regard to plant operation, commonly referred to in most plants as daily log data. The writer would direct your attention to an article in the March, 1927 issue of THE JOURNAL entitled "Essential Daily Log Data In The Pumping Station," written by Isaac S. Walker, General Manager of the New Chester Water Company, Philadelphia, Pa. Mr. Walker says, in part, "there are many small water plants operating in this country which, it might be truthfully stated, keep no permanent records whatever of their operations, or their water sales under different rates and classifications. This situation has

been improved materially, however, in the states under public service commission control."

Mr. Walker says further, in discussing "essential" data, that

"It is about as difficult to differentiate between essential and non-essential as it is to classify luxury and necessity. What is one man's luxury is another man's necessity. Similarly, what might be a non-essential in one water plant would be deemed an essential in another plant. But it is the history of civilization, that luxuries, by continued use become necessities, and water works records and statistics, which might at first be considered non-essential, by their continued use and demonstrated effectiveness, soon come to be absolutely essential. Properly kept records and data also tend to improve the plant morale and increase the attention and interest of the attendants. There is another important point in this connection. When operating records are maintained, there is always a tendency to improve the system. This leads invariably, under progressive management, to the introduction of recording instruments, which are necessary for the successful operation of a boiler room and pumping plant."

There are certain instruments which are essential to the intelligent and safe operation of a steam power pumping station. These include indicating boiler and feed pump pressure gauges and engine throttle pressure gauges, condenser vacuum gauges, water discharge pressure gauges, and boiler draft gauges. It is presumed that all steam operated plants are provided with this minimum supply of operating aids. Additional meters and gauges which are of primary importance in the study of plant operating efficiency include steam flow meters for each boiler, boiler feed water flow meter, carbon dioxide recorder, steam flow meters or a means of measuring condensate from each pumping engine, boiler make-up water meter, and recording thermometers for temperature of the weather, flue gases, feed water, and for steam temperature if superheated, and last, but far from least, some form of pump discharge flow meter. All flow meters should be at least of the recording type, as the recorder will serve very acceptably as an indicator and by use of a planimeter will provide the total flow. They should in most cases have twenty-four hour charts, thus providing a means of determining results daily. If means permit, indicating and integrating features can be included, thus enabling the full benefit to be gained from the installation, and simplifying the procurement of hourly observations. It is desirable also to have recording pressure gauges for steam pressure and pump discharge pressure.

In the small plant, where the operating crew consists only of an engineer and a fireman, it is not advisable to require the engineer to make too frequent observations of a great number of gauges, as these men have many other duties, and to this end, it is advisable to supplement all indicating pressure gauges with recording gauges wherever possible. Where the operating crew includes a sufficient number of men to make it feasible, this writer suggests that observations should be procured hourly from all essential meters and gauges, and recorded on the daily operating log, but in the small plant, particularly at night, interference with other duties may tend to cause laxity in this work, and a resultant "doctoring" of the records. Inaccurate records are apt to be worse than no records at all, and must be rigidly guarded against. Recording gauges, properly maintained and frequently checked, seldom tell other than the true story, and a complete set of "daily record charts for such instruments constitute the best kind of log data, and they should be carefully preserved in order and filed for permanent record." Here again may be raised the question of cost of installing a multitude of instruments. In the average plant the cost of pumping constitutes one of the largest, if not the largest single item of operating costs. It is then the logical thing to keep apace with the times, eliminate guess methods, and equip our plants with modern instruments, by means of which the overall efficiency can be materially improved.

Coal consumption

There is one very important item in essential log data which has not yet been touched upon in this paper. That item is coal. In the steam power pumping station, coal constitutes the largest single item of pumping costs, and the problem of pumping station efficiency resolves itself, in the final analysis, to getting the greatest possible return from the coal consumed. To this end, it behooves the man in charge to devise some means of measuring the coal consumed. In the large plant, with track hoppers and some type of mechanical conveyance to overhead bunkers discharging over coal scales, or weigh larries, to the stoker, the matter of determining coal consumption is relatively simple, however, the average pumping station has little or none of this equipment, and the problem is not so simple, but it can be solved.

At the Fall Creek pumping station of the Indianapolis Water Company we have a coal handling problem similar to that of the average

plant. At this station, coal is delivered in hopper bottom railroad cars to an elevated track in rear of the plant. The coal is there dumped to the ground, from which site it is shoveled into wheelbarrows and thus transported to the boiler room firing aisle floor. It is then shoveled into the stoker hoppers. This work is done, except under severe conditions of load or weather, when extra help is provided, by the fireman, as the boilers are fired by means of chain grate stokers and the normal duties of the fireman afford him ample time for wheeling and shoveling coal. Each fireman keeps an accurate tally of the number of wheelbarrow loads of coal he brings into the boiler room, and reports this number to the watch engineer on duty. The average weight of each barrow load of coal is known, having been determined by weighing a large number of loads on portable platform scales and dividing the total net weight by the number of loads. This weight is checked from time to time in the same manner, so as to determine whether or not the firemen are still loading the barrows with the same weight as before. The amount of coal consumed on each eight hour shift and on each day is thus known. The consumption is checked monthly in the following manner.

As the coal is dumped from the cars, the engineer on duty records the date, the railroad's car number, and the bay in which it is dumped. The net weight of each carload of coal is obtained from the railroad freight bill received by the purchasing agent. In using the coal, it is taken continuously from one carload until that carload is consumed, then from the car received next after the one just consumed, and so on, the other carloads remaining unmolested. In this way, the exact amount of coal in storage is known at all times, with the exception of the carload from which coal is being withdrawn. This pile is measured on the first of each month, and the cubic content multiplied by the unit weight of the coal. This weight, added to that of the complete carloads on hand, produces the amount of coal on hand the first of each month. Knowing the total weight of coal received during the month, it is then a simple matter to determine the amount of coal consumed, and this figure is checked against the total weight as calculated daily from the wheelbarrow record. This method of calculating and checking coal consumption produces surprisingly accurate results. This method of coal handling and accounting is one that can be applied, with suitable variations to fit local conditions, at any waterworks pumping station, and there is no reason for any

plant operator not to know how much coal he is using. It has already been stated that each boiler should be equipped with a steam flow meter. Having such meters, and having adopted some method of calculating coal consumption, it is then a simple matter to calculate boiler evaporation in pounds of steam generated per pound of coal burned. For purposes of comparison, if desired, this figure can be calculated on the "from and at 212 degree" basis, but since in normal operation the conditions of boiler pressure and feed water temperature do not vary greatly, it is ordinarily sufficient to calculate and compare evaporation on the apparent basis, that is, the amount of steam generated as indicated by the steam flow meter, divided by the pounds of coal used as fired.

If the laboratory of your waterworks possesses the necessary equipment, a sample of coal should be secured from each carload received and sent to the chemist for analysis, but if not, the coal company from which your coal is purchased would no doubt be glad to supply you with an average analysis, from time to time, of the coal you are receiving. From the heat value of the coal, having determined the amount of steam generated, and from pressure and temperature recorders on the boiler header and feed water header, respectively, it is then a simple matter to determine the overall efficiency of the boiler, furnace, and grate. However, as stated before, with operating conditions normally not varying, and with the heat content of the coal probably rather uniform, it is normally sufficient to determine the apparent evaporation of your boilers. This should be checked at least daily, and certainly not less than once each month.

Meters

While a flow meter on the boiler feed line is not essential, it does provide a means of checking the boiler steam flow meters. If the boiler water level is held uniform, it stands to reason that the weight of water fed to the boiler must equal the weight of steam generated. Thus the feed water flow meter not only shows the fireman that his feed pump is producing the desired amount, but also is a check against the boiler meter. However, as stated before, feed water flow meters, while useful, are not essential.

There is, however, one other meter essential to efficient operation of the plant. That is a boiler make-up meter. No plant is so perfect as to return to the boilers all the steam which is sent out. Leaks, vents, heating system losses, and the like all take their toll

from the steam and the condensate return systems, and a meter to measure the amount of make-up water used is essential. Fortunately, for this purpose, you may use a meter of the same type used on your customers service lines, as you will simply be measuring cold water. A meter of the domestic service size will suffice in most cases, and this is certainly not a great expense. A make-up meter will serve two purposes. Having installed such a meter and determined the normal make-up used daily with the entire plant in its normal condition, the meter will show immediately when something has happened to the system. An increase in make-up will indicate new losses, and the investigation and inspection which should naturally follow will in many cases result in the discovery of hitherto unsuspected leaks or wastes of boiler return. Such losses are expensive and to be avoided. Every boiler operator is aware of the results of increased raw water supply to the boilers in increased scale deposits and the resultant lowering of efficiency and, in some cases, failure of the boiler tubes or plates. If you soften your raw water before feeding it to the boilers, then increased make-up means increased softening costs; however, not all make-up variations are increases. Sometimes the make-up will be found to have decreased far below normal. In such cases, an investigation of the condensing equipment will often show burst tubes and leaking ferrules, with cooling water leaking into the steam space and being returned to the boiler room with the condensate. Thus it is seen that the make-up meter, while seemingly unimportant is actually a necessity in maintenance of high efficiency in your plant.

The two items of boiler evaporation and percent make-up are the two principal items of data which should be secured daily and monthly in every efficiently operated boiler plant. Mention has already been made of steam pressure and feed water temperature records. These are valuable aids to the chief engineer or superintendent in checking the daily operation of the boiler room. There should be, in fact, two thermometers for the boiler feed, one to record the temperature of water entering the heater and the other to record the temperature of the feed water entering the boiler. There should also be a carbon dioxide (better known as CO_2) meter on each boiler for the guidance of the fireman. With the proper instruction as to the use of this instrument, the fireman can be depended upon to get a higher efficiency from the boiler than is otherwise possible. This has been proved in many instances. Sometimes a spirit of

friendly rivalry can be established among the different firemen with boiler evaporation and CO_2 as the indicators of best results, but caution must be observed in such competition as sometimes the desire to make the best CO_2 record results in reduced efficiency; however, such a possibility does not offset the inherent value of the CO_2 meter judiciously used.

In the engine room, steam flow meters to measure the steam used by each unit are valuable, but not essential. If installed, they provide a means of checking the thermal efficiency of the prime mover, but in the average waterworks pumping station not a great deal can be done about such efficiencies. A well maintained engine will usually operate at its original efficiency, depending upon the load factor, less losses due to natural wear, pretty well throughout its lifetime. Such wear and maladjustment as tend to reduce the efficiency of an engine or a turbine will usually manifest themselves in other ways, but if your water department or company has any loose change to spend on additional equipment, steam flow meters for the engine can be made very useful.

We come now to the one meter which no pumping station can logically dispense with. That is the pump discharge meter. There are several types of meter on the market for this purpose, consisting chiefly of the venturi tube and the orifice type meters. The venturi tube is generally the most satisfactory, but local conditions will determine what is best suited to the individual plant. There is considerable disagreement among waterworks engineers as to the accuracy of flow meters measuring the discharge from reciprocating pumps, but it has been pretty well demonstrated that with careful engineering and proper installation they can be made to function with entire satisfaction. Let it suffice to say that whatever your local problem, if your pumping station is not now provided with pump discharge meters, it should be so provided, particularly in the case of centrifugal pumps.

For the reciprocating pump, very accurate results can be obtained from a record of pump revolutions, but a meter is still the most desirable means of measuring the discharge, as revolution counters do not account for leaky pump valves, plunger packing, or the like. As to their value in checking the operating efficiency of the pumping station, the answer should be obvious to all. It is a simple matter to balance pump revolutions against measured discharge from time to time to assure that the pumps are producing the greatest possible

output. Having both suction and discharge pressure recorders at the plant it is a simple matter, at least monthly, to determine the gallons pumped and the average total lift. From these data may be calculated the foot pounds of work done. By dividing this quantity by the hundreds of pounds of coal consumed during the month, that figure referred to in a foregoing paragraph as "station duty" may be determined and may be expressed as million foot pounds per hundred pounds of coal. This will be found a very useful figure for comparison of your pumping station's overall efficiency from month to month.

Operating records

In discussing the various data which may be derived from meters of various sorts, the writer has so far made no mention, except incidentally, of logs, or operating records. Naturally, if the fullest possible value is to be obtained from the meters there must be regular observations made of all meters, and they must be recorded on well designed log sheets. Records, to be valuable, must be accurately kept and so arranged as to be readily useful. It might be well to list certain items which should by all means be included on the daily operating log.

For the boiler room, there should be provisions for at least one daily observation of the steam flow meter. There should also be entries, for each boiler, of hours in service and in bank, and pounds of coal used. There should be a record of total pounds of boiler feed and make-up water used. It is assumed that pressure recorders have been installed for steam pressure and feed water temperature; if not, provision should be made for entry of these data on the log. Space should also be provided for each fireman to record unusual happenings or items of interest to the chief engineer or superintendent.

For the engine, or pump, room, hourly readings should be made of pump discharge meters or revolution counters, the latter data translated into gallons pumped. Provisions should also be made for recording total pumpage each hour and for twenty-four hours by all pumps, time of starting or shutting down each unit and hours in service, water temperature, outside air temperature, and any other data of value to the chief engineer in checking the efficiency of the plant. It is again assumed that the station discharge pressure is recorded on a recording pressure gauge, or better still, a gauge for each pump. These data just mentioned are the minimum necessary

for successful control of pumping station efficiency. More may be added to suit local conditions and as efficiency control may develop, but these at least should be secured, entered on the daily log, and turned in to the office of the chief engineer daily.

In the office, the basic data should be translated into the various items discussed in preceding paragraphs and again recorded on a master summary sheet. It should be so arranged as to make readily apparent, from day to day, just what results are being obtained. It is assumed that, the data having been once assembled and reduced to efficiency records, no chief engineer is going to sit idly back and let conditions run on as they will. Having found out what the plant is doing, and in what divisions of the plant deficiencies exist, the next logical step is to determine the cause or the source of these deficiencies and eliminate them by the proper repairs or adjustment of the deficient equipment.

It is well to set up certain optimum points, or goals, to be attained. By studying his own individual plant, and perhaps each unit, every chief engineer can and should determine what boiler evaporation, what percent make-up, and what station duty he considers good, and then set about to attain that goal. The many possibilities of mechanical improvement will soon present themselves to the operator who has equipped his plant with the many modern aids available to him and discussed in the foregoing paragraphs.

PERSONNEL

Last, but not least, in the matter of operating efficiency are the questions of personnel and general housekeeping. It is readily apparent to one who is at all familiar with the question of efficiency control that no matter how well designed the plant may be, and no matter how many aids are provided for the exercise of such control, it all depends, in the final analysis, on the man or men who perform the actual operation. The personnel of the operating shifts themselves must be reliable, competent, and efficient. The question of reliability of the personnel is one which can be determined only by trial, and if a man is found not to be reliable at all times he can not be left in a position of responsibility. As to competence and efficiency they can best be created in the men by practice and study. The practice, of course, can be given them in the plant, under the supervision of older, more experienced, operators. Whether or not they choose to study and to prepare themselves for the higher, more responsible

positions depends upon the interest they take in their work, and upon the opportunities offered them for advancement and improvement upon demonstration of their fitness for such recognition, and upon the security of their positions.

In the privately owned waterworks, so long as an employee does his work well he has little to fear in regard to the security or the permanence of his job, but in the municipal plant, these jobs are far too often looked upon by the politicians as plums to be distributed to their friends and political supporters. Such a situation does not, and can not lend assistance to a program of improved efficiency. Too often such political appointees do not possess either the knowledge or desire to make themselves really valuable to the chief engineer or superintendent, and indeed, the chief engineer himself is all too often more interested in the next election than in the efficient operation of the pumping station. In a community where such a situation exists the only solution can be civil service. The installation of civil service for the municipal waterworks is one in which every citizen should be vitally interested, for so much depends upon the personnel that only by effective control of employment and discharge can efficient personnel be assured. It is only with the assistance of interested and competent employees that effective control of pumping station efficiency can be attained.

General housekeeping, too, has a bearing upon the efficiency of the plant, as well as upon general appearances. Any plant operator should take pride in receiving favorable comments from visitors regarding the general appearance of his station. Furthermore, no plant which is allowed to become dirty and unkempt can be expected to be very efficient. Dirt and inefficiency go hand in hand, as do cleanliness and efficiency. While the clean plant is not always operating at its best efficiency, that is more often due to lack of intelligent information regarding the results being obtained than from lack of desire.

We may conclude, then, that to attain the highest possible efficiency in a waterworks pumping station, we must satisfy certain conditions. First, the plant must be so equipped and maintained as to be able to meet whatever demands may be placed upon it at any time. This equipment must include the necessary instruments and gauges for determining just what is going on in the various units in the several steps from energy delivered as coal to the work done in supplying water. Second, having installed the necessary equipment, including

instruments and gauges, to meet these conditions, accurate records must be maintained and the necessary steps taken to improve the efficiency whenever and wherever the records show the plant to be deficient. Last, but not least, the plant must be kept clean and orderly, and must be manned by competent, well trained personnel, who have the interest of the pumping station at heart and who may be depended upon to do their duty efficiently and faithfully.

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OPERATING RECORDS

By C. M. Roos

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In the preparation of this paper an effort has been made to discuss plant operating records in a manner which will be of interest primarily to those who have charge of and also to those who man the operation of pumping stations and purification plants.

The first animal life lived in the water and we today still are water animals, forced to live close by water or perish. We can exist many days without food and starve to death without great discomfort, but without water we suffer miserably and expire within two or three days' time. We refer to breathing air, but we actually breathe oxygen dissolved in water. The air we breathe must first be dissolved in the moisture in our lungs, and all of our food must be liquified before it can be assimilated.

Early civilizations were cradled in the valleys where streams supplied man and beast with this most valuable life sustaining commodity,—water. Primitive man lived close by water as he could not venture more than a few hours traveling time distance from it. He did not have facilities to transport water as later generations have had. The first efforts of man to transport water were crude and efficiency was not considered. The tread mill type of water wheel pump and the earthen water jars of the East are still reminders of primitive methods of transporting water.

One of the first evidences that man was rising in his standards of living was when he began to transport water and make it conveniently available where it was most needed. Bath tubs are a splendid index today of the living standards of any nation or community. A bath tub census compared with a population census tells a story from which many deductions can be made.

No other generation has had available the facilities we now have for producing a splendid quality of this life sustaining element, water, and for making it available in convenient form.

Today every community is entitled to water of unquestioned qual-

ity, readily accessible, conveniently served, and at a price which is reasonable. For health, cleanliness, comfort, convenience and protection against fire this quality of service is required. However, the producer, processor or purveyor of this most valuable commodity is entitled to a creditable and adequate monetary return or profit for his investment and service. Without an adequate return on the investment, and without compensation for service rendered, neither a privately nor a municipally owned water works system can be expected to keep pace with the constantly improving art or science of providing and serving water. It is foolish and short sighted to try to eliminate unduly the monetary or mercenary element from this or any other type of business, however much these terms have been recently condemned as being unholy. Monetary profit, properly controlled, still remains a bulwark of protection and safety for society.

However, the public is entitled to the benefits of modern equipment and facilities, and expertness in their handling and operation, all of which are now available, in supplying water. Without modern equipment and expert operation thereof the purveyor of this valuable commodity cannot give quality service at a reasonable charge. Proper equipment plus intelligent, diligent operation enable the operator of a water supply system to give a service of a high order at a reasonable charge and at the same time receive a fair return on the investment of money and energy involved. Real service and adequate profit go hand in hand. Rotary's slogan, "He profits most who serves best" is well coined. Profits are defined in this instance as monetary as well as including those other splendid profits, intangible but real, which come to him who serves well in any vocation.

With this more or less cautious approach to or preparation for a discussion of profits it should be safe to proceed to discuss profit and gain without being condemned by those advocates of business founded on something referred to by them as more ethical than wealth or monetary gain. Balancing budgets in water works operation is still a very essential and necessary chore, and he who fails to do so, awaiting some better plan to be successfully demonstrated, is facing a path which is not strewn with roses.

Accounting systems are thought of as that process of recording in terms of dollars and cents the results of transactions after such transactions can be reduced to dollars and cents language. In other

words, in most types of business much activity precedes the time when accounting in terms of dollars and cents can be done, which means that recording the dollars and cents of the job is in reality recording history. The water has gone over the dam before the accountant in the office deals with it in a definite way, and it is then too late to make corrections if by any chance because of error or mismanagement too much water went over the dam. It costs money to get back into the dam the water which has plunged over the spillway.

Therefore, a plan by which the operator can know definitely how much water is pouring over the dam each minute of the day, with facilities accurately to regulate the flow of such water to meet the actual demands or needs, has real value. If the operator then so regulates the flow so that by the time the bookkeeper in the office reduces the dam water to dollars and cents as it is consumed, the accountant is still recording history, something that has happened, but it is regulated, controlled, supervised history. This last statement includes three important hints, as follows:

(a) It is well to have a plan by which one can know how much water goes over the dam.

(b) It is equally well to have facilities to control the water going over the dam.

(c) The said knowledge and facilities are of no value unless intelligent use is made of them and the control facilities are properly operated.

It is not difficult to apply the theories or ideas herein discussed to the operation of a water works plant. When the monthly financial statement is prepared by the office accountant it is too late to change the plant record. Proper office accounting procedure is supposed to be an accurate record of facts, and like the laws of the Medes and the Persians, such facts and plant records cannot be changed. The water has already gone over the dam when the office accountant starts to prepare his monthly financial statement. Daily plant operating records recorded in terms other than dollars and cents are important because they give the operator knowledge of what is happening in his plant at the time it is happening, not at some later date. Of course, it is obvious that with such strictly current information about what is happening in his plant the operator should make use of it and cure operating ills at their first appearance before they can affect seriously the dollars and cents records when the history

of the operation is reduced to monetary terms at the end of the month. However, if the operator does not have his records in such form that he can intelligently interpret them, and be governed in his action by such intelligent interpretation, he can have his plant filled with records, recording instruments, meters, etc., and their value will be little or nothing.

Therefore, a system of recording or tabulating information given by the various recording and indicating instruments in the plant is of vital importance. The system must be illuminating to be of value. Any system of accounting or recording is without much value unless it enables one to use it profitably. It is this feature of plant operating records which should be emphasized. Too frequently water works plants which are well equipped with necessary gauges and measuring instruments do not have a suitable system of accounting or tabulating the instrument readings in such a manner that the operator can analyze his plant accurately and quickly and thus enable him to put his hand on the faulty item of operation promptly.

A trained nurse in a sick room charts her observations of her patient in such a manner that when the attending physician calls he is able to analyze the patient's condition at a glance, and he can then intelligently prescribe to cure the ills. The manner in which one organ of the human body functions has a direct bearing on the functioning of some other organ. So it is with the operation of the various units in a water plant, and the water works operator should have the daily log or chart so arranged or tabulated that he can readily compare results of certain operations which affect the operation of other units in the plant.

The daily plant operating records should be so recorded that the operator can quickly and easily compare for each unit the corresponding operations of other days, weeks, months and years.

There is no way by which a standard or stock set of records can be used for all water plants, as each plant should have a system of records designed to fit its own needs. However, the principle involved as herein referred to applies to all types of plants. It is not a simple task to design an ideal set of operating records for a water plant, but it is worth the effort to do the job and do it well. Money spent in securing expert advice and assistance in designing and installing such records is certainly a wise and profitable investment for any plant.

Why not have certified plant and industrial operating accountants

who use figures without the dollar mark or sign for this type of service, just as we have certified public accountants for dollars and cents accounting? Such a plan should prove profitable for a large percentage of all water works plants.

A word of caution at this point is in order. In many offices as in many plants the staff members and employees are victims and slaves of systems instead of being masters of them, and much is lost thereby both in dollars and otherwise. A proper system of plant operating accounting should include the following features:

1. Simplicity, to the extent possible without sacrificing quality.
2. Brevity, without sacrificing desired results.
3. Illuminating, so that it tells the needed story in language which can be understood by the plant employees.
4. Accuracy, so that records are dependable and authentic. Usually accuracy requires no more time and effort than inaccuracy in preparing records, and frequently much time and grief are saved thereafter by accurate original work.
5. Availability. The subordinates on the plant staff as well as the management should regularly inspect the operating records and should profit thereby.
6. Economical. The cost of maintaining any operating recording system should be reasonable and certainly such cost should and can be justified by the profits accruing from the use of such a system.
7. Adequate. The system should include all important items in the operation of a plant. Usually a complete operating recording system is inexpensive to install and to maintain. A complete system is just as inexpensive to maintain as is an incomplete one.
8. To the extent possible the system should use original records, or tie into and refer to records of original entry so that they are always readily available at any future date. This is important for the protection of the operator of a purification plant. In this respect records have a very definite value which cannot be measured in terms of dollars and cents.

The plant operator and all his assistants who have any part in preparing or accumulating data each day for the operating records should by reason of so doing become more efficient and capable as such work tends to acquaint those so engaged with each operation of the plant in a manner which otherwise would be impossible.

The operating records should be inspected and initialed each day by the management and then returned to the operators for their inspection of comments noted thereon before they are posted and filed. It is human to be more alert and efficient when one knows that reports of his work will be scrutinized by another. Then, too, the manager or superintendent cannot reap the benefits of such a system unless he personally keeps in touch with the information being thus currently tabulated.

A carefully and expertly designed system of operating accounting is less burdensome to maintain than one designed otherwise, and such records should reduce considerably the cost and burdens of plant maintenance. Orderly and systematic operation of anything is less burdensome and is less of a strain for the operator than is the operation of a disorderly system.

For all important units in a plant a system of recording daily their operation can be designed so that their efficiency can be currently determined as measured by the American Society of Mechanical Engineers Codes. Almost any kind of plant operation can now be measured, indicated and automatically recorded on charts by instruments which are available from reliable manufacturers at reasonable cost, and profits accruing from a proper installation and use of such instruments more than justify the investment therein.

Paying money out of the cash register freely and indiscriminately without a record thereof would be unthinkable to any careful business man. However, when we turn employees loose in a plant to use power, coal, steam, electric energy, heat, chemicals, etc., without a record of how efficiently they are being used, it is not much unlike paying money out of the cash register without a record of the payments. It does not matter how conscientious and honest the plant employees may be proper results cannot be obtained under such a system. The employees themselves are entitled to know what they are doing and the management must have proper current information about the operation of his plant if he is to do his best, which information he cannot have without proper operating records.

(*Presented before the Illinois Section meeting, April 10, 1936.*)

PROBLEMS OF THE ORDINARY SUPERINTENDENT OF WATER

By Frank J. Broz

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Many problems of the past years in Cicero exist in other cities, villages and towns, where the superintendent of water is appointed by a political body and takes over his duties with very little knowledge of the water works field.

The rapid turnover in water works superintendents is prevalent in Illinois, where changes in administrations mean new men in the water departments. The movement now on foot in Illinois will some day correct this condition.

Naturally, immediately upon taking office, the ordinary superintendent of water makes a perfunctory survey of his department and takes steps to correct the ills he is certain to find.

He takes over his department with the firm resolve to better the administration of his predecessor and begins to find problems that need to be solved immediately. In most cases his authority is limited by the political body which appointed him and he soon finds that he must first sell his employers on his recommendations.

This he finds quite a task as officials sometimes know less about the water system than he does, but they have power and authority and they exercise them.

The superintendent can sell his ideas in most cases if he is honest and aggressive. He often encourages opposition of the officials by starting off with the wrong foot.

If he has a board of water commissioners to work with, his problems can be solved more readily, particularly if the power of succession is vested in a board of commissioners; that is, where the remaining members appoint to fill vacancies which may arise. Briefly, his problems are as follows:

1. Personnel
2. Purchases of equipment, meters, tools, etc.
3. Reading of meters
4. Billing

5. Collections
6. Repairs to distribution system
7. Meter repairs
8. Improvement and extensions
9. Maps and records
10. Complaints of consumers

The personnel of his department is usually picked by elected officials and it is not uncommon for him to get a tailor as meter repairman or a retired tavern keeper as meter reader. He finds in his office men and women incapable of meeting the consumer and properly transacting the business so vitally necessary to a water office. And thus his problems begin. He must mould an organization with the untrained employees given him.

If he is tactful and persevering, he makes changes by transfers to other departments where persons have been misplaced. I have in mind one instance where a journeyman plumber drove a garbage wagon for three months before it was discovered he belonged in the water department.

His second problem deals with the necessary purchases of equipment, tools, meters, etc. Here he finds a real problem. He needs a number of items which should be bought, but the board or council decides otherwise. He becomes discouraged and allows his department to coast along instead of taking a firm stand on the necessities of the water bureau.

The proper reading of meters is a problem not to be lightly considered. The training of his meter readers should take place before they are allowed to read. He will find that readers get careless, yes, and they also practice collusion with certain consumers who are always ready to "fix" the meter reader when he calls.

He can correct this by switching meter readers in districts and by checking a few readings himself.

The choice of his meter readers should be very careful where he has control of employment. The meter readers can lighten the burden of the superintendent if he is intelligent and courteous. He is the contact man in the water department and can be trained to lessen complaints by making plumbing investigations where readings show abnormal consumptions. He should also test seals when reading as in a number of instances consumers will tamper with meters in order to avoid the just payment of their water bills.

Proper billing is simplified in departments where adequate ma-

chinery and competent help are available. In smaller offices the problem of catching accounts that show reductions of consumption is of utmost importance. Too often the superintendent is busy and does not check meter records. Here the billing clerk can be of service by being properly trained to make comparisons with previous periods and calling discrepancies to his attention.

Quarterly billings are preferable on small accounts and the cycle system will keep revenue coming in steadily. In a number of departments readings are taken twice yearly and billings made in such manner that for from four to six months of the year revenue is at low ebb.

Under the cycle system of billing a certain number of accounts are read, extended and billed each day.

The collection of accounts is one of the most important functions of the Bureau of Water. During the past four or five years, the worst depression period in the history of this country, collections have been of utmost concern to the ordinary superintendent of water. How to bring in the revenues necessary for the proper functioning of the water department, has been a problem difficult to solve in many cities. Conditions in various cities, villages and hamlets have not been the same. The relief load has not been identical in Illinois cities. In some cases water superintendents have been fortunate in being able to secure payment from relief consumers through the Illinois Emergency Relief Commission. Others have not been so fortunate, or better still, have overlooked the fact that payment could be secured. It is a known fact that the bottom of the cycle has been reached as witnessed by the fact that on monthly accounts in Cicero, collections have improved as follows:

1932	$77,100
1933	89,950
1934	101,500
1935	112,000

Some superintendents have been confronted with the problem of employing collectors to make consumers pay their bills. The writer believes that consumers should be trained to pay their bills at the water office and that enforcement of collections can be best effected through the shut-off rod.

The Department of Health for the State of Illinois has ruled that the towns, cities and villages have full home rule over the shutting

off of consumers and the superintendent of water should avail himself of this weapon where he feels it is necessary. Of course, the golden rule of tempering justice with mercy should be followed in some cases.

From observation it is apparent that the discount method is preferable to the penalty method, as witnessed by the fact that most public utilities employ discount methods.

Repairs to his distribution system are a constant problem and annoyance to the superintendent, particularly since the recent extremely cold weather.

It has been proved beyond a doubt that the distribution system is largely responsible for deplorable conditions in water departments. Underground and plumbing leakage must be constantly watched by the superintendent, because underground leakage constitutes in most cases a direct loss of water for which the department is not compensated. Plumbing leakage is a constant annoyance and is one of the main reasons for the majority of complaints received in his department.

A permanent leakage survey is a necessity in every water distribution system. Two or three men can be trained to sound services and mains and make plumbing inspections the year round.

Cicero has at present a W.P.A. project for the adjustment of curb boxes and meter vaults to levels of lawns and also a leakage survey.

During the leakage survey in 1933, over 1,900,000 gallons a day were stopped in main, service and hydrant leaks. It is estimated that an additional 2,000,000 gallons a day are being wasted through plumbing leaks.

In Cicero the consumer is being made water conscious by the distribution of pamphlets and by newspaper advertising. One ad now running in the English and foreign language papers reads:

> Over 2,000,000 gallons of water are being wasted each day in Cicero through faulty plumbing.
> Use all the water you need, but don't waste it!
> Keep your plumbing fixtures in repair.
>
> Bureau of Water.

A cut of a faucet dripping and another of a toilet bowl with flush box make up an attractive ad with the aforementioned facts.

The extreme weather of the past winter has affected every water distribution system and strict attention should be paid to repairs during the next few months.

Repairs to valves and hydrants constitute another problem claiming the attention of the head of the water department.

In Cicero approximately 60 valves were found with bent stems partly closed, or with stems twisted off entirely. This condition is brought about because plumbers, and inexperienced men of the water department were allowed to operate the valves.

A correction can be made of this condition by training one man to operate street valves properly and by keeping an accurate record of the number and direction of turn for each valve.

The proper maintenance of hydrants is another problem worthy of consideration. Hydrants should be checked systematically and periodically so that they are in proper condition for instant service in emergencies. Maintenance should not be left to inexperienced men, but rather to some one who will pack them properly, check and lubricate caps and see that they drain positively.

Meter repairs cannot be overlooked. Many of the ordinary superintendents pay little attention to the proper functioning of small meters.

There are many methods of making meter repairs but these facts should be kept in mind:

Buy meters recognized to be the best and keep them in repair. Replace worn or damaged parts. The figures in the bank account will more than justify any of the expenditures made.

In Cicero practically two-thirds of all meters have been gone over during the past four years. Revenues are increasing year by year.

During the depression years improvements and extensions to water distribution systems have not keept pace with the demands of the consumers. Bond issues have been very unpopular and because of decreased earnings many cities and towns are in great need of improvements. Many of the older systems are without an adequate number of fire hydrants and sufficiently large-sized mains to take care of the necessary water for fire protection.

One of the most acute problems of the superintendent is the recording of maps and records. Many departments are without plat books showing services, locations of curb boxes and meters, hydrants, valves, etc. Immediate steps should be taken to bring up-to-date complete map and record systems so that the superintendent has available at his command all matters pertaining to his department.

Complaints of consumers has been a constant nightmare and problem for the superintendent. The hard pressed home owner, watching

his dollars, has naturally complained on the slightest provocation. The superintendent can lighten his burden a great deal by keeping a very complete record, by testing his meters, and by investigating all complaints promptly. The employment of a man to handle complaints is essential. He must be tactful and of good personality. Cicero has a set of records which shows every call, all work done at the property, the number of flats and families in each building, whether or not creeping bent law exists whether or not ice machines are used, etc. In this way complaints of consumers can be handled intelligently.

These are but a few of the problems of the superintendent of water. Many others may exist which have not been touched upon, but it is hoped that this discourse may give the ordinary superintendent of water some ideas which he can inaugurate when he returns to his own department.

(*Presented before the Illinois Section meeting, April 11, 1936.*)

RECONDITIONING AN OLD WATER MAIN

By Alfred B. Anderson

(*Assistant Engineer, Division of Water, Newark, N. J.*)

During the past year or two considerable thought and study has been given to the transmission lines of the Water Supply System of the City of Newark, with the result that a comprehensive program has been developed to rehabilitate the old steel pipe lines.

The first step in this program, which will extend over a period of several years, was the reconditioning of the first five and a half miles of the No. 2 Pequannock pipe line. This line is one of two 48-inch pipe lines which run from the Pequannock watershed to the City of Newark. These lines were laid some forty years ago by the East Jersey Water Company under contract to the City of Newark, and have been in service continuously since that time. The condition of the steel plate was such that it was deemed advisable and economical to recondition them rather than construct a new line.

Bids were asked for the cleaning and relining with a $\frac{1}{4}$-inch coating of cement mortar placed by centrifugal machine. The contract was awarded to the T. A. Gillespie Company as General Contractors, who in turn sublet the rough cleaning to the National Water Main Cleaning Company.

The cleaning consisted of removing the rust tubercles, deposits, remains of the original asphalt lining and other foreign matter from the interior surface of the pipe, to permit a bond between the cement lining and the steel.

In order to facilitate cleaning and subsequent operations, the City provided removable sections approximately eight feet long with Dresser Coupling joints at either end of each of the four sections into which the job was divided.

In preparing these removable sections the pipe was first burned on an angle allowing the section to be readily removed. In order to use Dresser Couplings on the riveted pipe it was necessary to remove all the rivets in the horizontal lap joints for a distance of 12 inches on one side of the cut and 8 inches on the other. Also, in place of

having two thicknesses of plate at the lap joint, one of the sections of plate in the joint had to be removed, a welded butt joint made, and the rivet holes filled by welding.

As this was a tapered pipe and out of round, it had to be shaped and either crimped or flared to fit the Dresser Couplings. This work was undertaken by City forces immediately after the pipe was dewatered.

CLEANING

In order to determine the amount of work necessary to clean this 30,000 feet of pipe, several test sections—each one-foot long—were carefully scraped by hand, the material collected in bags and weighed. The average weight of the material was found to be 7 pounds per lineal foot of pipe. Over a distance of 30,000 feet this would mean the removal of 105 tons of material. Contrary to the usual practice of machine cleaning, i.e., removing the incrustation and not damaging the existing coating, it then became necessary to remove all the old asphalt coating to permit a bond between the cement lining and the steel. Special springs were placed in back of the steel scrapers of the cleaning machine to do this.

The usual method of cleaning water mains was followed. The removable piece of pipe on the upstream end of the section to be cleaned was taken out, the machine inserted in the pipe, and the removable section replaced. At the opposite end the removable section was taken out and a timber bulkhead built about two feet away from the end of the pipe. This was done to prevent the machine from flying out of the pipe, for such a procedure might cause a partial vacuum in this thin shelled pipe and cause it to collapse. The water was then turned on.

As the machine was forced through the pipe line by the water pressure a sufficient quantity of wash water was permitted to pass through it to keep the scraped material in suspension so that it could be removed through blow-offs opened ahead of the machine. The speed of the machine was controlled by operating a 48-inch sluice gate at the inlet of the pipe line and could be practically stopped at will.

The longest section cleaned was 16,000 feet—it being necessary to send the machine through a second time. An inspection was made immediately following the second trip and it was estimated that 75 percent of the cleaning had been done, or that 42 tons of material had been removed.

Additional fine cleaning had to be done after the cleaning machine had gone through the pipe. Hand scrapers and wire brushes were used to clean around rivets, etc., before the cement lining was placed.

CEMENT LINING

Previous to the starting of the lining operations, the City of Newark engaged the Howard Inspecting and Testing Laboratories of Newark to select the sand and cement best suited for this work, together with their proportions. Physical and chemical tests of the sands submitted were made and a sand selected that was well graded, sharp, pure silica and free from foreign matter such as clay and organic substances.

Physical and chemical tests were also made to select a slow-setting cement which (after being incorporated in the mortar) would be non-leaching, adhere firmly to the pipe, be dense and have a smooth surface. Fifteen samples were submitted from different brands of Portland Cement with no identification other than a number. This was done so that the testing could be carried on without knowledge of the commercial origin or trade names of the cements. Four of the fifteen were found to be well adapted to this work and the key numbers were forwarded to the Contractor who was permitted to make his selections from this group. The sand and cement were delivered to the contractor's yard where under cover the sand was dried and carefully sieved through a twelve-mesh screen; the cement was carefully sieved through a sixteen-mesh screen, and both weighed out in bags of exactly eighty-five pounds each.

The mixers were housed in a canvas shelter which was heated with coke-burning salamanders. During zero weather lining operations continued and the temperature in the shelter remained at 50 degrees F. The water was also heated and the temperature of the mix remained at 40 degrees, which was the temperature in the pipe.

Sand and cement were hauled to the mixers in covered trucks as required. The mix consisted of one part sand, one part cement and three and a quarter gallons of water to each bag of cement.

After mixing for five minutes, the mortar was dropped through the entrance manhole into the hopper of an electrically driven pneumatic-tired buggy in the pipe, which in turn dumped the cement mortar into the storage hopper of the screw conveyor attached to the back

of the lining machine. The conveyor was also electrically driven and manually controlled so that the hopper of the lining machine was filled at all times.

From the hopper of the lining machine the mortar passed through a slow speed screw to the 6-inch cylindrical liner head, around the circumference of which there are rectangular orifices. As the mortar flowed through the orifices, it was thrown by radially spaced vanes travelling at 1,000 r.p.m. in a fine spray to the walls of the pipe. Directly in back of the liner head there are four steel trowels, two of which turn clockwise and two counter-clockwise. These trowels are mounted on a slowly revolving shaft projecting through the liner head and are so adjusted that their curved surfaces float the mortar and give the inside of the pipe a smooth finish.

Power for these several machines was furnished by a portable electric generator and transmitted through cables wound on synchronized reels attached to the back of each machine.

The thickness of the cement mortar lining was controlled by the speed of the lining machine. For a quarter-inch coating, the rate of travel was fixed at approximately four feet per minute.

Although an average day's work consisted of lining 500 feet of pipe, the record for this contract was 1,088 lineal feet in 344 actual operating minutes (or approximately three feet a minute) which indicates the speed with which this work can be done under ideal conditions.

Eight hours after a section has been lined, rubber bulkheads made of automobile inner tubes and sheet rubber were placed and the section steam cured for at least forty-eight hours.

At the end of each day's run, all the machinery was carefully cleaned and reassembled in the pipe ready for the next day's work.

(*Presented before the New York Section meeting, March 27, 1936.*)

NEW WATER WORKS OPERATING PRACTICES

By F. E. Stuart

(Research Engineer, Water Purification Division, Activated Alum Corporation, New York, N. Y.)

Operating practices are constantly changing. Some of them are interesting and practical, others not practical for all purpose work. These are given to stimulate interest in "How the Other Fellow Does Things."

The subjects outlined in this paper may not be entirely clear, but an attempt is made to show how the other fellow does things without going into much detail. If more detail is desired, the author will try to get the information upon your request.

GENERAL OPERATING PRACTICES

The abnormal accumulation and liberation of dissolved gases when washing filters causes large mounds and hard spots in the filters. Weir at Atlanta installed a $\frac{3}{4}$ inch tap on each manifold segment and connected them together by means of a streamlined copper pipe and vented at a point above the water level in the filters. A $\frac{3}{4}$ inch angle globe valve was placed on the end of this vent pipe in order that air might be released from the manifold through the pipe instead of passing up through the sand and gravel strata.

Superintendent Jesser of Covington, Va., Water Department, uses a Pemberthy cut-off valve with float on the pressure line to the chemical solution tanks. If, for any reason, the chemicals do not go in solution fast enough or the discharge line becomes plugged up, the influent water will be shut off when the water in the tank reaches a high level. This is a pretty good idea and insures high velocities through the solution tanks without danger of overflowing.

Esty of Danvers, Massachusetts, connects an air compressor to hydrant and forces the water out of the main through another hydrant on the line. This eliminates so much pumping when working on a break.

At Fort Pierce, Florida, Superintendent H. A. Gahn treats a

surface water, which in brief is a very difficult water to treat—color ranging from 200 to 600—with practically no alkalinity—pH below 6 most of the time.

This plant is pointed out because of the different modern methods of treatment used, which produce a palatable water low in color and free from corrosion.

The flow scheme consists of

Treatment	*Pounds per million gallons*
Prechlorination	2
Soda Ash	100-120
Black Alum	250-300
Carbon	20- 24
Post Chlorine	7
Post Ammonia (Ammonia added last)	2
Lime	50- 60

Weir and Smith at Atlanta use an inflated inner tube to float 25 pound sacks of copper sulphate crystals. The inner circle of the tube being spider-webbed with small rope to hold the bag of copper sulphate. This is most effective in shallow water and near rocky shores.

Superintendent Watkins of Oneonta, N. Y., has found activated alum a more flexible coagulant for conditioning water for filtration through pressure filters. When using activated carbon and alum separately, he had occasional trouble with carbon particles passing through the filters. When activated alum treatment was begun, this difficulty was overcome and a smaller dosage of coagulant did the same work.

P. W. Frisk, Chemical Director, American Enka Corporation, Enka, N. C., has a simple way to dissolve manganese, using 1½ percent solution of caustic soda. Allow this to remain in contact with the filter sand for 6 to 7 hours. He says this will remove most manganese when the filter is washed. A little manganese is a good thing on the filter sand, as it acts as a catalyst.

Superintendent Moss of Highpoint, N. C., uses a 2 percent solution of sulphuric acid, adding the acid to 6 inches of water in the filter. He claims that this removes the black coating which is formed on the top 3 inches of sand. Allow this 2 per cent solution of sulphuric acid to remain in the filters two hours.

Chief Chemist Chandler of the Greenwich Water Company, Greenwich, Conn., adds lime ahead of the filters at approximately

$\frac{1}{4}$ grain per gallon during seasons of manganese trouble. The average manganese is between 0.5 and 0.7 p.p.m. in the raw water. The average color of the water is between 30 and 35 p.p.m. He recommends the use of a high wash rate between 42 and 29 inches in the summer and winter. Chandler says the first few days, when lime is added to the water flowing to the filters, you will get a breaking through of floc. After a few days, however, the sand will become conditioned and will then act in removing the manganese, as well as the color.

Superintendent Moss of Highpoint, N. C., adds lime ahead of the filters similar to the method explained above, for the control of his manganese problem.

Some operators mix two pounds of carbon with ammonium sulphate to prevent it from picking up moisture. This improves the feeding qualities and prevents arching in the hopper. Carbon will do the same thing with iron sulphate. This is the reason activated alum feeds so uniformly under bad operating conditions.

Chief Chemist Hoover of the Columbus, Ohio, water softening plant, has designed and built a burette stand which has indirect electric lighting. This light is used at all times for alkalinity and other readings to compensate for the errors commonly occurring between daytime and nighttime operators.

Cranch of New Rochelle, N. Y., Water Department, has converted a hand forge blower to supply air to old manholes, thus eliminating the danger for workmen in these manholes. A waterproof cloth tube transmits the air from the blower. The unit is portable.

Superintendent Mills of Southern Pines, N. C., is using the latest type flow scheme. The trend toward the most economical method for taste control is through the combination of black alum coagulation and activated carbon added to each filter after washing.

By using activated alum in the pretreatment, the floc is conditioned for high color removal. By adding the total dosage of carbon needed for final taste control (6 pounds per million gallons) to each filter after washing, there is no lag in taste control. When adding carbon continuously to the water flowing to the filters, there is more carbon on the filter when it is taken out of service for washing than at any other time. Likewise on the other hand when the filter is placed back in service after washing, there is insufficient carbon on the filter for several hours to remove all the taste.

This new flow scheme is therefore more economical and more effective.

Treatment		*Pounds per million gallons*
Prechlorination		4.5 to 6.5
Lime	Average	32
Black Alum	Average	140 to 175
Activated Carbon (Added to each filter after washing)		6
Post Chlorine	Average	2 to 2.5
Post Lime	Average	112 to 128

OPERATING PRACTICES AT HACKENSACK WATER COMPANY NEW MILFORD, N. J. PLANT

A box for depositing ideas for employees has resulted in many worthwhile suggestions, the employees being compensated according to the value of the suggestion.

A very interesting relief map, size 3 feet by 6 feet, scale horizontal—1 inch, is 1760 feet, vertical—1 inch is 200 feet, is located in the main entrance to the filter operating gallery. This shows the visitor the area of the water shed at a glance, location and size of various pumping stations, elevated storage and reservoirs, also the towns supplied by the plant.

This certainly shows at a glance a story which would be very hard to tell.

A series of cast iron pipes, old and new, lined and unlined, show the effect of different waters on different type mains. This model distribution system is flexible in operation. The results obtained have been very much worthwhile.

Whenever new purification ideas need a try-out to satisfy Sanitary Engineer Spalding, he puts them through their paces in his pilot plant. (You will recall that Spalding is the one responsible for the practical application of activated carbon now used in about a thousand water plants.)

During certain seasons of the year a continuous dosage of copper sulphate is applied to the raw water entering the plant. Dosages are varied to meet local conditions. The writer understands this to be effective in algae control. Other observers claim longer filter runs when adding copper sulphate to the water entering the plant.

Hackensack has used powdered activated carbon continuously since its introduction there in 1930. The carbon is applied by dry feed machine equipped with a water ejector to the mixing chamber. The

carbon stabilizes the sludge and reduces the tastes and odors; average dosage being 5 to 8 pounds per million gallons. The carbon is added continuously to the mixing chamber, securing taste and odor control through stabilization of sludge and the carry-over of carbon to the filters by the floc.

METER REPAIR DEPARTMENT PRACTICES, NEW ROCHELLE WATER COMPANY, NEW ROCHELLE, N. Y.

Water meter castings are painted by spray gun equipment. The meter casting sits on a turntable which revolves slowly. The colors used are bronze and aluminum.

Cranch and Brown of New Rochelle Water Company have installed air chambers on the influent side of all the meter testing machines. This eliminates water hammer caused by the quick opening and shutting valves, especially effective when testing large size meters.

The use of expensive Monel metal baskets for dipping meter parts in Dearborn 134 solution has been much more economical than the use of cheaper baskets.

An electric drill held in place by a suitable clamp arrangement is used for cleaning meter parts. The drill is substituted for a rotary wire brush. This cleans meter parts in a hurry.

The uses of compressed air in a meter repair shop are many. This added convenience in meter shop repair work will speak for itself.

The use of a hand press similar to the press used on electric drills is a sure way of observing the fit of the disc in the chamber before the meter is put together. This eliminates the guess work connected with tight or ill-fitting discs.

An elevated container of gear lubricant is directly connected to a quick opening valve with spring attachment. This gives positive control of the amount of lubricant added to the gear train chamber because it closes so quickly, thus eliminating the mess which generally accompanies the handling of gear lubricant.

(*Presented before the New York Section meeting, March 27, 1936.*)

PUBLIC WORKS ADMINISTRATION WATER PROJECTS IN ILLINOIS

By Carl H. Bauer

(*State Director, Public Works Administration, Chicago, Ill.*)

From 1926 to 1929 national expenditures on construction were $12,000,000,000 per year, three-fourths of this vast sum being provided by private interests. Three million Americans were employed directly on construction. By 1933 the construction had been reduced to a mere $3,000,000,000, only one-half of which was provided by private construction. This decrease added vastly to the unemployment of the country.

The stagnation in public works was due in a large measure to the inability of municipalities and public bodies to sell their securities. This was brought about by poor collection of taxes and the need of expending moneys for direct relief. This stopping of public and private construction had its effect in the basic industries. Forests, mills, factories, quarries, were shut down. The effect of this stopping of the supply of these materials greatly decreased the volume of traffic carried by the railroads and other transportation facilities. As construction dwindled, the architects and engineers, superintendents, foremen, skilled and unskilled labor were thrown out of employment.

The contraction of construction, and its resultant effects, began early in the depression and continued until President Roosevelt, recognizing the need of a public works program to revive the basic industries of the nation and to put men back to work, recommended to Congress the establishment of the Public Works Administration. The Federal Emergency Public Works Administration was established on June 16, 1933.

Up to the first of this year the Public Works Administration has furnished 10,300,000 man-months of employment. More men are employed in indirect labor on construction than in direct labor; some economists give this ratio as 5:1. The secondary labor employed was 20,600,000 man-months. This was all provided at a high wage scale.

Every State in the Union has been given allotments. In fact, there are only six counties in the entire United States which have not received allotments from the Public Works Administration. Sixteen thousand two hundred (16,200) projects already have been completed at an approximate cost of $1,000,000,000. There are under construction throughout the nation 5,200 projects valued at $2,200,000,000. Two thousand (2,000) more projects are about ready to get under construction. This is the national picture. Sixty per cent, or approximately $1,224,000,000, of Public Works Administration funds have been expended for materials up to the first of the year.

ILLINOIS ALLOTMENTS

In Illinois 153 projects have been completed at a total cost of $28,300,000. Two hundred sixty-two (262) projects are now under construction, valued at $123,000,000, and 18 projects, with an estimated value of $5,000,000, are ready to start.

Under the old program 22 percent of the funds was allotted for school projects and under the new program school projects received 33 percent of the funds allotted; sewer projects received 15 percent of the funds allotted under the old program and 13 percent under the new program. Percentages for water projects were 44 and 18 respectively, and for hospitals 2 as against 6. One percent of the old program funds and 3 of the new were for bridges and viaducts. For miscellaneous improvements, such as community buildings, gas and power projects, municipal buildings, etc., the percentages were 7 and 12. The reasons for this increase of school building were that we appreciated the need and social value of school building, and because such projects fitted better into our program for winter construction. The vast difference in waterworks, from 44 to 18 percent, was due to the fact that these projects did not suit winter construction. Otherwise the percentages are practically the same. The paving increase to 15 percent was due to the large Cook County road program of $9,000,000. The difference in bridges was due to the worthwhile Outer Drive program in Chicago.

METHOD OF OPERATION

The Public Works Administration is not responsible for the origin of these projects. That is a function of the local elected officials. To submit an application to the Public Works Administration for an

allotment of funds it was necessary that the municipalities use their own engineers or employ private architects and engineers. This rule immediately created a large amount of work for the various architects and engineers as is evidenced by the fact that we received 700 applications in Illinois, amounting to $200,000,000, more money than was allotted to the entire national Public Works Administration.

All work under the Public Works Administration is awarded to contractors. The contract is between the municipality and the contractor. Public Works Administration's contract is with the municipality. All work is advertised and bids taken under the supervision of the Public Works Administration. The law specifically requires that the lowest responsible bidder obtain the work. This procedure immediately put the contractor's organization to work, resulting in the hiring of engineers, material-men, time keepers, superintendents, foremen, and various allied building craftsmen.

As stated before, there have been 20,600,000 man-months of indirect labor provided by the Public Works Administration program. The increase in work was apparent in the mines, forests, quarries, mills, and factories, by the railroads and other transportation facilities. Sixty percent of the money has been expended for materials worth, roughly, $1,224,000,000. The effect of these large orders was immediately noticeable in the business structure of the country.

The communities were benefited by the Public Works Administration because all work has let out to contractors and work was done more efficiently because it was done under contract, and in most cases it was done at a low level of cost. This followed because of decreased costs during a depression period. Labor needed the employment, the contractor wanted to keep his organization together and his equipment busy. The community derived excellent and permanent assets As examples of what the Public Works Administration has added to the assets of the State, your attention is called to the five large Chicago high schools, the Cook County Nurses' Home, the Chicago Sanitary District, the Lake Springfield project, and the work at the State hospitals for the insane. Under construction we have the fifteen grade schools in Chicago, various police and fire stations, the Outer Drive Bridges, and three bridges over the Chicago River: North and South Ashland Avenue Bridges, and the Torrence Avenue Bridge.

The Public Works Administration, through the examination of plans and specifications, through its financial, engineering and legal

work has determined that all these projects are socially and economically sound and desirable. Through the Inspection Division, the supervision of construction and the opening of the bids we have obtained a value to the tax-payer of 100 cents on the dollar.

There has never been any question raised as to the results of the Public Works Administration. This vast program has been executed without graft, corruption or skimpy work, and there has not been the least accusation against the Public Works Administration—even with a hostile press which has been eager to unearth something unfavorable. We have been instructed to keep our records and procedure so that at any time a Congressional investigation could be made without the calling of witnesses. In other words, we have an incontestable record. One time at the beginning of this vast program the question arose at the suggestion of some of our well-meaning citizens that possibly it would be better to allow the normal amount of graft and sharp practices that were supposed to be prevalent in public work to exist for the sake of speed. Mr. Ickes decided that Public Works Administration money would be spent without the slightest inference of misuse, and it is now shown that his decision was wise. Much of the chagrin of some of our citizens he has proved that a vast program of this kind can be accomplished without any graft whatsoever, and without delays. There has never been an attempt by any outside agency to ask for an investigation regarding the operation of the Public Works Administration. You gentlemen who have dealt with the Public Works Administration can testify that there has never been so much as a suggestion of any irregularity. I have repeatedly heard statements from men who have sold materials for years, that out of five or six thousand contacts with the Public Works Administration on projects there has never been so much as an indication of suspicion.

The Public Works Administration has always insisted that men must not only be put to work, but that they must be returned to work at a fair wage level with every protection that is available is normal times. This is best borne out by the fact that in two and one-half years in Illinois we have had practically no labor disputes. We have returned men on the thirty hour a week schedule. On the first program we insisted on a \$0.50 minimum for unskilled labor and a \$1.20 minimum for skilled labor. Under the new law we have established a prevailing wage in the community at the time of the advertisement of the award. We insisted that local pref-

erences be given to the workers. These employees could be obtained from the National Reemployment Service or the State Employment Service or through the unions direct. The contractor is allowed his skeleton organization and under the new program he is permitted to employ men who have previously worked for him and who are now on relief. No convict labor may be employed. Only American citizens are employed; we have repeatedly forced out all aliens.

The Public Works Administration does not discriminate between Union and non-Union. The contractor makes his choice and that is final. We have protected the contractor and laborer from kick-backs. This has been beneficial both to the laborer and the contractor. Chiselling has stopped. We have enforced those provisions. Men have been found guilty of receiving rebates from labor or other infractions of the rules and regulations. As you know, there is a penalty clause on all contracts calling for ten years in prison or $10,000 fine for false statements. This means that in the employing of labor under these conditions there have been fewer irresponsible contractors. We have insisted on a financial statement, a bid bond, and a completion bond, full insurance converages as compensation, public liability, etc. This is done not only to protect labor but to protect the contractor, the architect or the engineer.

Prevailing wages are determined by ordinance of the borrowing community and checked by the State Director's office through the Inspection Division and Investigations Division, and by the unions and contractors. Under the new law the prevailing wage, which, is minimum wage, by agreement with the unions, is to be effective throughout the life of the project.

Those of you who had public works projects pending in 1933 were unable to finance these projects or get them under way. There was no municipal bond market because of the slowness of the collection of taxes and the need for direct relief. The Public Works Administration loaned the communities funds at 4 percent interest, taking such collateral as the applicant's bonds reasonably secured. These may be general obligation bonds, revenue bonds, or special bonds. This financing was done after it was determined that the projects were socially beneficial, economically feasible, and of financial, engineering and legal soundness. This immediately caused a revival of the bond market. The Public Works Administration purchased over $300,000,000 worth of this collateral and sold it through the R.F.C. at a $5,000,000 profit. This money was returned to our

revolving fund for future loans to communities. In Illinois under the first program 55 percent of our projects were loans and grants and 45 percent were grants only. Under the new program we have only 22 percent of the projects as loan and grants, while 78 percent are grants only, showing that the local bodies were able to sell their bonds locally at a better rate of interest than the 4 percent established by the Public Works Administration. Before the Public Works Administration started projects could not have been financed at any rate of interest.

What delay there was in the early history of the Public Works Administration was due in a large part to the reluctance on the part of the elected local officials to take action. Because their agreement was with the Federal Government they were very cautious; in many instances, too cautious. There were difficulties in some cases in the selection of the engineers, the attorneys, the choice of materials to be used, in citizens' committees protesting against one or another feature of the project, the difficulties of preparing bond ordinances and obtaining approval of the expenditure of money when the community was near the debt limit, and slowness in carrying out of condemnation proceedings. We solved the problem of preference of materials by insisting that the engineer on the project was responsible for the project and therefore must determine the type of material to be used. At times this was difficult for some of the aldermen and mayors and other politicians to understand. But you gentlemen can readily realize that when there were six hydrants all at the same price it was not easy to decide which one was to be used.

The elected officials and the regular employees of the community had to perform the duties assigned to them, but in those communities in which there were no such officials the communities hired attorneys, bond counsel, and engineers at the percentages as approved by the American Society of Engineers, the societies of architects, etc. We have had very little trouble in the establishment of their fees. In a few cases architects or lawyers have insisted on a larger fee because they considered a project called for more work than usual. We approved a fee which could be included in the cost of the project. If the community desires to pay a greater fee than that, they must find means of financing it.

The criticism for slowness has not come from the communities with which we have been dealing. This criticism has come from the Press. Some was justified on the first program as we had devised

no method of expediting or forcing the City Fathers to make up their mind. But benefiting by our errors, time limits were set up under the second program. The President in an order set the date of December 15, 1935, as the time when all bids should be taken. We have changed this date from time to time in a small percentage of projects as local conditions warranted. The result is that our present program is 98 percent under construction, because those communities which failed to coöperate and get their work under construction had their loan and grant agreements rescinded.

When Mr. Ickes was appointed Administrator of the Public Works Administration he had no organization, no program, no plans, because nothing like the Public Works Administration's program had ever been done to form a precedent. First, this program had to be established. The idea of public works with a grant and loan from the Government had to be sold to the community. An organization had to be perfected. This, of course, took time because there were so many policies to be established. It is not necessary to go into detail concerning this story; the results speak for themselves.

One of the wisest moves in this entire program was in the recommendation of a lump sum appropriation to the President. After all the various departments of the Public Works Administration recommended an allotment, and this allotment had the approval of Mr. Ickes, it was then sent to the White House to the President, the only man who had the power to allot money for projects. This was beneficial in many ways, but the main point is that these projects were picked for their social and economic desirability, legal, financial and engineering soundness with no pork-barrelism at any time.

Everyone here knows about the result of Mr. Ickes' ideas. I can best point out his ideas about the organization of the Public Works Administration by repeating his phrase that the best politics for the Public Works Administration is no politics. He has built up a very efficient and worthwhile organization. He can point with pride to the Public Works Administration even though it is only one of his many, many duties.

DECENTRALIZATION

The State Director's functions in the program have been enlarged by the decentralization of the organization from Washington. Under

the old program all records had to be referred to Washington for examination by the engineering, legal and financial divisions. Under the new program the State Director has a complete organization in the State and acts for the Administrator in that State.

The State Director must have an intimate knowledge of all of the projects because he had the power to override any recommendations made by the various divisions. He may approve the recommendations of the various divisions for the allotment of funds. After these recommendations are made they are submitted to Washington for final approval and allotment of funds. That this decentralization expedited the entire program considerably is apparent when it is understood that 98 percent of our program is under construction.

Loan and grants under the Act are made to States, municipalities, school districts, drainage districts, etc. In approving projects under the new program, priority was given to those projects which could be put under construction immediately and be completed within one year. The projects given preference are waterworks, sewer systems, electric light plants, streets and highways, bridges, schools, hospitals and recreational facilities.

The State Director has under his jurisdiction engineering, legal, finance sections. The function of the engineering section is to examine the plans and specfications and to pass on the project as to its engineering soundness only. We are very careful never to criticize design. We do check estimates, all contract documents, all bid openings, and all change orders.

The legal section passes on bond ordinances and the legality of the entire project, and it is seldom that after our legal section has completed its study there is any opportunity for legal action.

The finance section determines the financial possibilities of the project. It passes upon such revenue features as water rates, etc. It checks to see that the community has not exceeded its bond limit and that the securities offered are marketable. After the allotment has been made the community may request the Public Works Administration to purchase its bonds. Under the new program, however, we have found that a large share of the communities are selling their securities locally. As soon as the bonds have been purchased by the Government or sold locally, and the money is deposited in the bank, we will allow construction to start. We also give 15 percent as advance grant to allow for the drawing of plans, specifications, taking soundings, etc. As soon as the funds are in the bank

and construction started we allow another 10 percent of the grant. Ten percent more is allowed when the project is 70 percent completed, and the final 10 percent, making the total of 45 percent grant, is made after construction is completed. This money is drawn from the bank on the borrower's vouchers to pay the contractor after the Resident Engineer Inspector has determined that all bills have been paid on preceding vouchers and that the estimate of partial payment is reasonable.

INSPECTION AND INVESTIGATION

In addition to certifying to these facts, the Resident Engineer Inspector is at the site of the project to coöperate with the borrower and the contractor. It is his duty to see that the project is built in accordance with plans and specifications and that the materials and labor are furnished in the quantity and quality called for. The value of this inspection service, which is given gratis, is a precaution taken in every project to see that the community obtains one hundred cents on every dollar expended. It is assurance that there will be no graft or corruption or skimpy work.

The Auditing Division has auditors who call on the borrowing community at various times. During the first visit they set up accounts, see that the money is properly deposited in the bank, and thereafter check all facts as to expenditures of funds. They audit the local community's books, the contractor's books, and if necessary the material supplier's books. The purpose of this auditing is to prevent the transfer of funds other than those called for by the Certificate of Purpose and insures the community that funds borrowed for this project will be expended on the project only. It often prevents funds being foolishly spent.

The Investigations Division is a double check. Before the bid opening and at the bid opening they have a representative present and at any time during construction they might have a representative call to inspect the project and conduct interviews regarding the project in the community.

In the new program there were over 700 projects submitted to this office at a value exceeding \$200,000,000. Of this group we accepted 214 projects valued at approximately \$54,000,000. Some of the projects were found to be engineering, legally, or financially unsound and others were not socially desirable. Of the 400 projects remaining there is a possibility that they will go ahead if further

allotments of money are received from Congress. These projects, as you may have noted from the Press, have all been examined and meet the requirements of the Public Works Administration. There is a large amount of work that can be accomplished if we are given the funds. Whether that will come will be determined entirely by Congress.

The Public Works Administration in the broad outlines that I have indicated has been a gigantic undertaking which has supplied jobs and provided for the expenditure of money in the construction of useful projects. The Public Works Administration has benefited the communities which sponsored the projects, industry, and the financial structure of the entire nation.

In conclusion, I wish to quote from the speech of Colonel H. B. Hackett, Assistant Administrator, on January 29, in St. Louis.

"If we are to make any program effective, whether in depression or prosperity, it must be founded on three cardinal principles: (1) It must be prepared and comprehensively planned in advance. (2) It must contemplate expenditure adequate to the need. (3) It must be free from politics, both in conception and administration.

"With such a program in the hands of courageous leaders, we may face the storm of future depressions without the fear of despair which has demoralized us in the past. Probably we cannot prevent such storms, but when they come we can to a great extent mitigate their fury by providing a sound roof over our heads."

(*Presented before the Illinois Section meeting, April 10, 1936.*)

THE WORKS PROGRESS ADMINISTRATION AND WATER WORKS OPPORTUNITIES

By Arthur H. Myers

(*Assistant Administrator, Works Progress Administration, Albany, N. Y.*)

In appearing before the American Water Works Association, I have been requested to answer ten questions regarding the Works Progress Administration. These questions are those which most frequently present themselves to municipal executives.

Question No. 1. The aim and purpose of the Works Progress Administration.

The purpose of the work program, as stated by the President in his request to the Congress for funds for emergency relief, is "to provide relief, work relief and to increase employment by providing for useful projects." The major objective was that "work must be found for able-bodied but destitute workers." Employment was to be given to employable persons then on relief, pending their absorption in private employment.

The fundamental principles governing the Works Progress Administration are:

1. All work undertaken shall be useful—not just for a day, or a year, but useful in the sense that it affords permanent improvement in living conditions or that it creates future new wealth for the Nation.

2. Compensation shall be in the form of security payments which are larger than the dole but not so large as to encourage the rejection of private employment or the leaving of private employment to engage in government work.

3. Projects shall be undertaken on which a large percentage of direct labor can be used.

4. The projects undertaken shall be selected and planned so as to compete as little as possible with private enterprises.

5. Efforts shall be made to locate projects where they will serve the greatest unemployment needs, as shown by eligible relief rolls.

The ultimate aim of the W.P.A. being the enrichment of human lives, the government has the primary duty to use its emergency expenditures as much as possible to serve those who cannot secure the advantage of private capital.

The types of projects for which the money appropriated by the Act may be used were defined in very broad terms. Eight major classifications were stated:

Highways, roads, streets and grade-crossing elimination.
Rural rehabilitation.
Rural electrification.
Housing.
Assistance for educational, professional and clerical persons.
Civilian Conservation Corps.
Loans or grants or both.
Sanitation, prevention of soil erosion, stream pollution, sea coast erosion, reforestation, etc.

Of the classifications just mentioned, grade-crossing elimination, rural rehabilitation, rural electrification, C.C.C. and loans and grant are within the province of other governmental agencies.

The Works Progress Administration was charged by the President with the responsibility for "the honest, efficient, speedy and coordinated execution of the work relief program as a whole and for the execution of that program in such a manner as to move from the relief rolls to work on such projects or in private employment the maximum number of persons in the shortest time possible."

To effect this purpose, it was designated to carry on small useful projects designed to assure a maximum of employment in all localities. No building project exceeding $25,000 in federal funds could be prosecuted by W.P.A. This regulation is in a state of suspension at present, since the P.W.A. is receiving no new applications.

By Executive order, certain other federal agencies have been designated to perform functions in the work program. All workers, except such essential supervisory employees as are necessary, must be secured from the National Reemployment Service. The Employment Service fills all requisitions for labor from among cases certified to it by the local welfare departments as eligible for and having received relief between May and November 1, 1935. Workers cannot be requisitioned from the Employment Service by name, only by occupation.

Payment of workers is made by the Accounts and Disbursing Divisions of the Treasury Department.

All materials, supplies and equipment paid from federal funds are purchased through the Procurement Division of the Treasury Department.

The Works Progress Administration is the operating agency of the work program. All proposed projects pass through its hands for initial approval or disapproval. It recommends to the President the projects which should be prosecuted to absorb the unemployment load in the various municipalities.

The W.P.A. does not originate the project proposals. The communities of the state have the primary responsibility of deciding whether to keep their employable relief cases on home relief or at useful work. The municipalities must sponsor and submit the proposed work to the W.P.A. Any regularly constituted department of local government or tax supported institution may request approval of projects. No work may be done for individuals or private organizations or on private property unless it is part of a public improvement and rights of way and waivers against property damage and liability have been secured.

In considering project applications, the proposal is examined for various conditions. First, there must be a sufficient number of eligible relief workers with the occupational skills required in the vicinity of the proposed work. The ratio of wages to other costs must be sufficiently high to justify the expenditure of relief funds. The undertaking must be one that is not normally done with budget funds or is a regular municipal function. The project must be one that can be completed before June 30, 1936. The estimate of costs must be reasonable and must be accompanied by plans in sufficient detail to allow for intelligent consideration. The sponsor's contribution to the project must be reasonable.

Question No. 2. The duration of the W.P.A. While no official date of termination has been set for the work program, we have been directed by Washington to approve to start no project which cannot be completed before July 1, 1936. The continuation of the Works Progress Administration beyond that date will be determined by new funds being made available by the Congress.

Question No. 3. The community quota of employables. The number of people eligible for employment by the Works Progress Administration in a given community is governed by the number of

certified, employable relief cases who had been granted relief between May and November 1, 1935. To put to work all of the eligible relief cases, the community must submit sufficient worth-while projects to absorb its load. These projects must meet the conditions I previously outlined.

Question No. 4. Does W.P.A. contemplate absorbing the list of present unassignables who came on relief rolls before and after November, 1935? The Works Progress Administration will absorb all of the physically and mentally qualified relief cases who were granted relief between May and November 1, 1935, provided sufficient projects have been submitted. At the present time, we are powerless to put to work cases who became relief recipients subsequent to November 1, 1935. We are not allowed to by Washington and I do not believe that there is sufficient money available to cover the added cost.

Question No. 5. To what financial degree will the W.P.A. participate in total costs of projects?

The federal government pays all of the wages on W.P.A. projects. It will also pay a portion of the cost of materials, supplies and equipment. However, it will not pay all of the costs. It is not reasonable for any municipality to expect the government to not only take care of its relief cases, but to build capital improvements also, at no cost locally.

There is no hard and fast rule as to the amount which must be contributed locally to W.P.A. projects. Each proposal is considered separately and on its individual merits. A reasonable contribution is all that is expected unless the proposed project is for a type of work which is predominantely a high material and equipment job. In that case, the W.P.A. would expect the sponsor to assume a major portion of the other than wages cost.

The one thing to bear in mind is that the money allotted for W.P.A. operations in New York State is limited. Every dollar that is spent by the government for other than labor costs is that much less available for wages. The work program is a coöperative venture in which the government joins with the municipality in relieving unemployment on the one hand and improving local facilities on the other.

For purposes of computation, in making out project applications, between 20 and 30 percent of the total cost should be included as the minimum contribution. Some enterprising engineers have overestimated the labor requirements so that the man-year cost of the

project would appear low. However, these are isolated cases and generally are returned to the sponsor for re-figuring.

Question No. 6. What is the meaning of allowance of $740 per man year? The $740 applied only to certain districts within the State. Other districts had other man-year allowances, based on the population, which governs the security rate paid to W.P.A. workers.

The man-year allowance originally was based on the total number of people to be employed divided into the total amount of federal funds available, corrected for the districts within the five security wage classifications. This man-year cost, which was the amount of federal money allowable for one man for one year, including wages, equipment, materials and other costs, was the average to be spent by the federal government. All costs over that average had to be contributed by the sponsor.

Some municipalities tried to have all of their projects fall within the man-year limit, in an attempt to have the federal government bear all of the cost of taking care of their unemployed. As an idea, this was all right. However, the Works Progress Administration is charged with the responsibility of prosecuting work which is "useful in the sense that it affords permanent improvement." In cases such as those cited above, we found it necessary to insist on better projects being submitted. We do not intend to operate a leaf-raking program.

Question No. 7. Will the W.P.A. make 100 percent material grants on worthwhile projects provided the local community cannot, on account of its financial condition finance them? We have in mind previous relief programs which did. By making 100 percent material grants, the question apparently means, will the federal government pay for the project in its entirety? The Works Progress Administration will give consideration to the financial condition of every community and will not insist on more than the community can reasonably bear.

I worked for the Temporary Emergency Relief Administration for more than three years and I recall only one city in the state which was carried 100 percent by that Administration. That city, incidentally, is now contributing a portion of its relief costs.

Question No. 8. Will W.P.A., in an instance where it appears more economical, make an outright purchase of equipment, rather than rent it? In such a case, we would purchase the equipment; probably on a rental-purchase agreement.

Question No. 9. Does title to materials purchased for local projects from W.P.A. funds become the property of the locality, or is owner-

ship and control retained by the W.P.A? All materials purchased from federal funds, which are not consumed on the project, remain federal property and are transferred to another project where such materials are needed and are to be supplied by the Works Progress Administration. Materials used on the job and which are an integral part of the completed project become the property of the sponsor.

Question No. 10. Has the W.P.A. any provisions for safety supervision on local projects or protection for the public? The same provisions are made for the safety of both workers and the public as prevail on private work. Every project has a safety man, often trained in Red Cross First Aid work, whose responsibility it is to see that all hazards are removed from the job. In addition, we have traveling superintendents and field engineers whose duty it is to check on the work of the job safety men and to report and immediately correct any unsafe conditions found to exist.

I have frequently been asked how materials, supplies and equipment are secured for projects.

All materials, supplies and equipment which are furnished by W.P.A. are secured by the Procurement Division of the Treasury Department in accordance with federal purchase procedure. Such items furnished by the sponsor are purchased in whatever manner he desires. The W.P.A., however, requires that copies of paid invoices be furnished so that they may have evidence that the sponsor is abiding by his promise in the matter of contributions.

The W.P.A. program is a golden opportunity for the water works superintendents and engineers to have work accomplished which they have been contemplating for a long time; work for which funds have never been available from budget appropriations. There are men on the relief rolls who are as equally skilled as any. They have creditably completed extensions to water supplies; built dams and reservoirs; improved, modernized and added extensions to pumping stations. Mr. Drake has had some experience with relief workers with the high pressure mains in Buffalo and will bear me out in the statement that excellent results may be accomplished with these men.

I shall not attempt to "sell" you the idea of submitting W.P.A. projects for your departments. We have thousands of approved projects as a reservoir, to be used when existing projects are completed. I merely want to call to your attention the opportunity that is before you, if you desire to take advantage of it. The decision must be yours.

(*Presented before the New York Section meeting, March 27, 1936.*)

PHYSIOLOGICAL EFFECTS OF MINERAL SALTS IN NATURAL WATERS

By C. B. Pollard

(Associate Professor of Chemistry, University of Florida, Gainesville, Fla.)

A review of the literature dealing with physiological effects of minerals in natural waters indicates that we have not been logical in the derivation of our results. Since the consumption of water involves every human being, the majority of whom have had no scientific training, it is not surprising that public opinions have been moulded without consideration of the logic of the conclusions. Many results which have been accepted have come from uncontrolled experiments which cannot in any manner be classified as scientific research.

During the seventeenth century when Louis XIV was king of France he became gravely ill with typhoid fever. In spite of the polish and education of the day the king's water supply had been contaminated with sewage. For some weeks the fate of the king was uncertain. The king was bled, purged and poulticed; every known remedy was tried. His physicians were helpless and desperate. Finally as a last resort they gave him a dose of antimony. Soon he improved and then rapidly recovered. At once his recovery was attributed to the powers of antimony. They used the type of argument that Plutarch used. The king took antimony, he got well; therefore antimony must have cured him. These men did not understand the principles of science, they did not think logically. We of course now realize the king recovered in spite of the antimony and not because of it. Although this case is taken from an early date this same type of faulty logic exists today.

Thousands of people who visit mineral springs attribute miraculous healing powers to many mineral waters with the contention that their maladies vanished with the drinking of the water. They fail to consider that during the water treatment their entire mode of living was changed. They forgot that they have been playing, resting and

drinking far more than normal quantities of water and living under entirely different environments. We are well aware that many maladies respond to rest, recreation, change of living conditions and that waste materials are flushed from our systems by increased consumption of water. Regardless of these facts the patients ignore all except the mineral content of the water. In many cases it is highly probable that distilled water consumed in the same quantities would have produced the same effect.

Although a great deal of research work in this field has not been done we do now realize the importance of reliable results from carefully controlled experiments. In some cases we find conflicting results from experimental work which indicate that some factors have not been controlled with sufficient care. Scientific research is tedious, slow and expensive, but reliable results are well worth the price.

Hard waters have been blamed for such diseases as urinary concretions, arteriosclerosis, dyspepsia, goiter, diarrhea, constipation, rheumatism and stomach disorders. At a meeting of English medical men in 1911 Lewis (1) exonerated hard waters. He contended that many people retiring from active work go to seacoast towns where the water is hard and then blame the hard water for their ailments without considering their own inactivity. He stated that when medicinal doses of calcium salts are given, only small amounts enter the circulation, and their effects outside the digestive tract are not very profound. The calcium content of the blood is raised with difficulty by feeding calcium salts and these compounds are of little assistance when the body needs to assimilate more calcium as it does in cases of rickets and fractures. Lewis also states that bottled waters are frequently substituted for the harder local supplies by the upper class of people and no increase in illness has been noted.

In contrast we find some European authorities (2) who have noted that better teeth, body weight and nerves are produced in communities where hard water is used for drinking. If hard water is a suitable source of available calcium its importance to bone and teeth development in children is of course obvious.

In view of the variety of opinions with respect to the rôle of hard waters in the formation of kidney stones Meyers (3) made a study of this problem. Using rats and rabbits as test animals he proceeded on the theory that a solid object must first be present in the urinary tract to act as a nucleus for a concretion. By first introducing a foreign solid into the bladder he was able to produce concretions.

However, he found but little more deposition from hard than from soft distilled water. He concluded that even though hard waters may contribute more solid matter to urinary concretions than do soft waters, an abnormal condition must first exist or the stones will not form.

From the rather limited study of mortality rates the tentative conclusion may be reached that the statistical evidence indicates no relation between hardness in drinking water and deaths from diseases of the arteries, kidneys and bladder. It would be of great interest, however, to extend this inquiry by making a detailed study of mortality in specific municipalities with water supplies of various degrees of hardness and with various proportions of permanent and temporary hardness.

Lewis contends that if calcium is needed by a degenerative process the body store provides this without calling on that which is present in drinking water. Part of the mineral matter from water is undoubtedly used. The body is able, however, to eliminate most of the minerals through the intestine and kidneys. Cumulative poisons are an exception, but since these are normally not found in municipal supplies they warrant no consideration here. In general, the salts which are eliminated by the intestines are those which are not absorbed through its walls. Salts such as magnesium sulfate (Epsom salt) and sodium sulfate (Glaubers salt) carry water with them through the intestines and are strong purgatives when used in large doses. However, but few public water supplies carry enough of these salts to exert a pronounced physiological effect.

The bicarbonates of calcium and magnesium are frequently encountered in drinking waters. Their presence has been the source of considerable discussion. Bicarbonates are of course present in the body and are essential in aiding the blood to resist conditions which would tend to shift the acid-alkali balance which must be held within rather narrow limits. It is reported that as much as 5 gms. per day of sodium bicarbonate can be tolerated by a normal person before shifting the urine to the alkaline side. This indicates that the bicarbonate is neutralized by the hydrochloric acid of the stomach. However, authorities differ in their opinions concerning the rôles of carbonates and hydroxides in digestion.

Salts such as sodium chloride (4) and sodium nitrate are capable of passing through the intestinal walls, are absorbed by the kidneys and eliminated in the urine. This produces thirst and satisfaction

of the thirst flushes the salt from the system. Potassium nitrate seems to be more effective in this respect and is sometimes used as a diuretic (5). The necessary dosage is small enough to include some natural waters (6). Any form of nitrogen in water indicates organic pollution, but where nitrate is the only form found the organic matter has been oxidized to its greatest extent and is considered harmless from a sanitary standpoint.

Sherman (7) places the actual requirement for iron in the case of adults at about 0.01 grain per day. Iron is used by the organism in the production of the hemoglobin of the red blood corpuscles and in the formation of other hemo compounds which are widely distributed in tissues where they play important rôles in cellular oxidation. Whipple and his associates (8) have contributed much to our knowledge of the relation of diet to blood regeneration. They have shown that meat, particularly that of organs (heart and liver) is especially beneficial in hemoglobin and red cell formation. There has been considerable variation of opinions with respect to whether iron salts that occur in water could be assimilated by the body (9). However, the work of Hart, Steenbock, Waddell and Elvehjem shows that the ash of beef liver is as effective as the liver in stimulating the utilization of iron and the production of red blood corpuscles. However, since iron produces an unpleasant taste and rust spots it is highly improbable that we shall ever depend on the iron content of drinking water for our body supply of iron.

Manganese is occasionally found in natural waters and has been credited with the production of dark stains on teeth (10).

Recent research work has shown that even pure copper salts, such as copper sulfate, exert a favorable effect in preventing and curing nutritional anemia. This work has stimulated research investigations dealing with aluminum, zinc and manganese.

The question of the rôle of iodine in maintaining optimum conditions for health has long been under discussion. Conflicting data leave us where we wonder that the correct answer will be.

Marine and Kimball (11) showed that iodine was deficient in parts of Switzerland and the Great Lakes region where goiter was quite common.

Shore and Andrew (12) report that a study of three different areas shows that no relation could be observed between the incidence of goiter in school children and the amount of iodine available.

Krauze (13) reports a wide variation in the iodine content of the

waters of Poland. Statistics show no relation between the iodine content of the waters and the occurrence of goiter.

Van Dyke (14) has obtained results which indicate that iodine from iodides is more readily absorbed by the body than iodine from iodates. Free iodine is not readily absorbed.

In 1924, Olsen (15) summarizing the data on iodine administration states that numerous methods have been proposed but the most suitable one is administration of a chocolate tablet containing 10 mg. of iodine in the form of an organic acid. He comments on iodized foods and water and calls attention to the fact that the hyper-susceptible cases of goiter are in great danger.

At a recent demonstration (16) in the RCA Building in New York a group of executives witnessed with unusual interest the almost unbelievable action of colloidal iodine on a withered orchid. The orchid, dead from a practical point of view, was taken from a trash heap. A teaspoonful of an amber-tinted liquid was added to the quart of water in the bottle which held the orchid. The orchid bloomed again, its petals fresh, crisp and its colors vivid. The amber-tinted liquid was colloidal iodine. Apparently the physiological effects of colloidal iodine are quite different from those of free iodine.

The elements hydrogen, carbon, oxygen, nitrogen, sulfur, phosphorus, potassium, sodium, lithium, calcium, magnesium, iron, silicon, chlorine, bromine, iodine, fluorine, aluminum, arsenic, cobalt, copper, nickel, zinc and vanadium are known to be more or less widely distributed in animal tissues. A number of these elements are found in only minute quantities within living organisms. In view of this, little or no attention has been paid to their presence or function until recently. Although the percentage of some of these elements in the human body amounts to a very small value (0.01–0.16 percent) we may find that even the very small amounts are far more essential to health than we have ever imagined. A considerable amount of research on fluorine in Florida waters, (17) is being done at the present time. We await the results of this work with a great deal of interest.

The discovery of one new truth which can be utilized to improve health will make our research efforts well worthwhile.

(*Presented before the Florida Section meeting, April 1, 1936.*)

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WATER QUALITY DETERIORATION IN DISTRIBUTION SYSTEMS

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This subject covers a wide field, much greater than is commonly supposed. After going through the often laborious process of treating a water supply, in a manner that when it reaches the consumer it is or should be of good quality and fit in every way for domestic purposes, we are usually content to consider our worries temporarily over, and leave to the distribution section the task of servicing the supply. How often do we consider what can happen to water after it enters the distribution system, which in many instances includes service reservoirs and water tanks acting as balancing units. In this paper without being unduly alarming, it is proposed to outline and later to discuss briefly some of the changes which can occur in the distribution system.

For the purpose of classification we can arrange possible trouble conditions into Physical, Chemical, Microscopical and Bacteriological groupings. Under the physical heading we can include any kind of suspended matter, turbidity, secondary precipitation and red water. Under chemical the presence of offensive gases and iron, lead, copper, zinc and sulphur. The microscopic grouping may be said to include all types of plankton life, certain forms of crustacea, crenothrix and worms. The bacteriological list probably includes a larger number of possible causes of deterioration than all the rest put together. In this group we find the presence of the colon-aerogenes class of bacteria the cause of which is later discussed, the presence of spore forming or symbiotic bacteria, coli-like forms of bacteria occurring in leather, jute and fibre packing used in pumps, hydrants and tap washers, bacteria growing as a result of secondary decomposition, saprophytic leptospiras and others.

PHYSICAL CHANGES

In discussing the physical changes which may occur in water mains, it is generally recognised that most complaints of dirt and turbidity in the distribution system, are the direct result of either flushing, the

want of flushing or fluctuations in water pressure. Trouble may be more intensive at dead ends. Another cause of similar conditions are broken mains resulting in a temporary ingress of dirt and sometimes soil worms. It could well be asked what steps are taken to guard against the introduction of more serious contamination. We know little of what happens at such times, chiefly because they are regarded as emergency conditions and repairs have necessarily to be made as rapidly as possible. Open service reservoirs are sometimes responsible for turbid water conditions particularly when the sides of the reservoir are not concreted up to the top. Heavy rainfall or wind action may cause considerable quantities of suspended matter to be washed off the sides. This ultimately finds its way into the distribution system. In one case which the writer was investigating, filtered water having a zero turbidity discharged directly into a service reservoir prior to entering the distribution system. The sides of the reservoir were lined with a shale-like stone, and during wind storms the surface was washed off into the water to such an extent that the water entering the distribution system often had a turbidity of 10 parts per million.

Secondary precipitation and red water are closely allied and may be the direct result of incomplete treatment at the purification works. We know these conditions are associated with pre-treatment of the raw water, which due to its nature or reaction may have involved coagulation difficulties. Red water is invariably due to the final reaction of the water entering the distribution system. Undecomposed alum passing into the supply will also cause the same trouble. Any water having a pH below 7.0 will have a corrosive tendency on all kinds of service pipes. Experience has shown that in water which has been subjected to correction for the prevention of corrosion, a pH of at least 9.6 may be necessary to prevent red water in the distribution system.

Physical troubles of all kinds have been caused in localised areas, by the use of cross-connections between the water supply system and sewerage or drainage systems, industrial supplies, and swimming pools, and are extensively reported in the literature. The general condemnation and prohibition of cross-connections on public water supplies has been widely recommended, yet we are still faced not only with this dangerous hazard, but also with the possibility of back siphoning from defective plumbing fixtures. How many of these potential hazards exist is not known, because a majority of

them were built a considerable time ago and a close check up is difficult. It is perhaps fortunate that modern regulations controlling the installation of cross-connections and plumbing fixtures, have been made so rigid that approval is now rarely given unless the operating conditions are fool proof.

CHEMICAL SUBSTANCES

While the presence of chemical substances in water are invariably due to the corrosive action of certain supplies, bacterial action may also be involved. Thus we find that a slightly corrosive water will dissolve iron, lead, zinc and copper and a softened supply devoid of dissolved oxygen may cause the iron to be attacked inside the mains. Water containing small quantities of lead or zinc may be highly toxic in its action. Consequently the reaction of water in the distribution system should be so controlled as to prevent plumbo-solvent or zinc dissolving action. In regard to zinc, most trouble has been experienced with low grade galvanised pipe which is more susceptible to attack. Little danger exists of copper poisoning under ordinary conditions, the action being slower than in the case of lead or zinc and the human system can stand considerable quantities of copper without ill effects. In England, the deposition of copper in cistern water as a result of electric wires being in contact with water pipes has been reported. In such cases the copper ball float was chemically broken down, the copper salts being slowly dissolved in the cistern water supplying the residence. The presence of sulphur or sulphur compounds in the distribution system, may occur through their liberation in water as a result of pumping notably in deep well supplies which have not been aerated or as direct result of bacterial action causing sulphur reduction. Cases have been reported of bacteria attacking sulphur contained in pipe jointing material, not only causing the liberation of sulphur compounds, but resulting in leakage at the joints. Complaints have been reported at dead ends, of sulphur odors. The cause of this is somewhat obscure, excepting that the odor was probably not of the nature complained of and was due to decomposing organic matter in stagnant water. These would not occur if systematic flushing was employed or if an active disinfecting agent such as chloramine were used instead of straight chlorine.

MICRO-ORGANISMS

The part played by micro-organisms other than bacteria in the distribution system are numerous. In a majority of cases they have

their origin in filtered water open service reservoirs, and apart from the occasional complaint from consumers are relatively unimportant. Where unfiltered water containing algae is pumped directly into supply taste and odors may develop in the distribution system and growths actually occur within the mains. From service reservoirs many varieties have been identified with the diatomaceae group predominating. Various forms of crustacea often grow in reservoirs and pass into the distribution system causing complaints. Certain types of worms thrive in soil around reservoirs and others may be washed in by heavy rain. While they are harmless their appearance in the distribution system is particularly objectionable. Mention should perhaps be made of the entrance of different kinds of worms into taps from unusual sources. In one case reported in the literature, the wash-room basin discharged directly into a closed drain consisting of open-jointed earthenware pipe which upon examination was found to be harboring thousands of worms of the nais variety. Some of these worked their way up the waste pipe into the basin and the tap, being expelled from the tap when the water was turned on. Mention is particularly made of this because of the difficulty which at first was experienced in convincing the householder that the worms had not come through the service pipes. There have also been cases reported of the presence of water fleas and small worms in hydrants, sometimes being present in large numbers. Just how they got there and multiplied is a mystery. Localised chlorination was usually employed with success. The growth of crenothrix in water mains is sometimes the cause of much trouble. This organism once seeded thrives in water rich in carbon dioxide which dissolves the iron and supplies food for the organism to live on. It will only grow in iron bearing waters and deferrisation of the water is one of the best methods for correction. Apart from the foul odors sometimes produced by its decomposition, the worst nuisance created is the partial obstruction of the water mains. The association of certain types of micro-organisms in conjunction with chlorine, which may cause taste and odors in the distribution system is hardly within the scope of this paper and will not be dealt with.

BACTERIAL GROWTHS

By far the greatest problems encountered are connected with secondary bacterial growths in the distribution system. The types we are chiefly concerned with are members of the colon-aerogenes group, certain spore forming bacteria which have resisted chlorina-

tion and those pseudocolon forms associated with leather and pump packing. The chief causes for the presence of B. Coli in the distribution system, can be said to be associated with stirred up sediment in water mains particularly at dead ends as a result of varying water pressure or flushing. Contamination of water in open service reservoirs as a result of bird or fish life, soil bacteria, surface drainage, dust, the accidental or deliberate introduction of foreign matter is common. Cross-connections and contamination caused by the use of new water mains without treatment complete the picture.

When water entering the distribution system is sterile, as it mostly is, and the danger of cross connections does not exist, while we are worried at the occasional presence of B. Coli in the tap water, its significance may be greatly overestimated. Just why sediment in water mains contains B. Coli we do not know. Neither are we able to differentiate B. Coli of human or animal origin. Consequently the contamination by bird and fish life in open reservoirs while objectionable is not necessarily serious. We know that B. Coli feeds on dead organisms and organic matter which may be present as a result of the chlorine reaction on living organisms. The only sure prevention of B. Coli in the distribution system is by the use of a sterilising reagent which remains active in the mains. Chlorine alone while effective in a majority of cases is not always present in sufficient quantity in dead end areas, to prevent bacterial decomposition. The presence of spore forming bacteria in a distribution system is a difficult question to solve on account of the known fact that B. Welchi is able to survive fairly heavy doses of chlorine. Laboratory demonstration alone can prove the identity of the bacillus, and this having been done, its sanitary significance can be ignored.

The seriousness of faulty cross-connections etc. cannot be overestimated. Numerous epidemics of gastro-enteritis, typhoid fever and amebic dysentery have occurred in the past, and one can only hope that the day is not distant when cross-connections between the public water supply and private property will be made a statutory offence.

The use of water tanks and cisterns in buildings is another source of potential danger. We know of instances where sewage or sump water has got into such structures as a result of leaky pipes dripping on to faulty covers. Again the possible access of rodents to cisterns and reservoirs might cause leptospiral and salmonella infections. Houston in England reported that the presence of saprophytic leptospiras in storage reservoirs, filter under-drains, service reservoirs and

water mains might be capable of causing spirochaetal jaundice. Of a large number of leptospiras isolated from the previously mentioned sources, he was only able to demonstrate two having pathogenic characteristics. We are however comforted by the thought that leptospiras are extremely susceptible to chlorine only a small dose being necessary to destroy them.

While it is becoming standard practice to sterilise new water mains prior to use, there are many municipalities which still fail to do this. Records show that not only is it important that new mains should be sterilised, but that such mains should not be placed in commission before bacterial tests indicate that the water in them is free from all contamination.

The last question which it is proposed to discuss is associated with contaminations which can arise from leather, jute and fibre washers used in pumps, hydrants and taps. Both in this country and abroad, bacteria very closely allied to the colon-aerogenes group have been isolated from water in contact with these substances, and in some cases adverse reports on water quality caused by this medium have been made. It need hardly be pointed out that little or no danger exists from this source, but a lot of anxiety and embarrassment can result from such unlooked for causes of contamination. One point which should be emphasised, centers around the status of the water supply should an epidemic of gastro-enteritis occur. We might be satisfied that it had no connection with the supply yet in court it might be very difficult to prove that water containing B. Coli of other than human origin, was incapable of causing disease, although we might feel satisfied that such was the case, based upon the quality of the water originally entering the distribution system.

The findings of the Committee of the American Public Health Association in 1929, under the Chairmanship of J. R. Baylis of Chicago on bacterial aftergrowths in water distribution systems is of interest and reads in part as follows:

"There are 48 open reservoirs in the cities reporting bacterial increases. As to how many of these reservoirs contributed to the bacterial increase, there is no definite information (13 cities reported no bacterial aftergrowths). There is no positive evidence that such increases constitute a menace to health, yet there is no way of telling just how much of the increase was due to pollution and how much to aftergrowth. Bacterial increases especially B. Coli tend to render unreliable our main criterion for judging the safety of water. When there is the possibility of pollution, as there is for all open reservoirs, the increase in B. Coli content should not be ignored even though there is

good evidence that the increase is due to the B. Coli growing on decaying micro-organisms. The B. Coli content of the water need not be the sole standard of quality, but the same factors that are used in judging the quality of the water entering the distribution system should apply to the water from all open reservoirs, tanks and standpipes. Sampling points should be established throughout the distribution system so that the water from all reservoirs etc. will be tested with a frequency that will ensure a fairly good check on the quality of the water."

There are other causes of water quality deterioration in the distribution system, but it was the idea of the writer in this paper to enlarge upon conditions more commonly encountered, attention to which had been drawn in technical literature. The presentation of this somewhat gloomy picture had for its objective the dissemination of information which might outline the causes of occasional trouble encountered in the distribution system, which water supply authorities are sometimes called upon to explain.

The late Sir Alexander Houston once stated:

"It is said that bacteriologists are alarmists in relation to their bacterial findings. The truth is that all bacteriologists of any repute abide by current teaching, which frankly admits that a gross pollution of non-specific sort may be harmless, and an apparently trivial contamination may be most dangerous in virtue of its specific character."

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REFORESTATION AND WATER RESOURCES

By Arthur Herbert Richardson

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In recent years a great deal of interest has been aroused in connection with the establishing of protection forests. By these are meant areas of woodland or bush which form the watersheds of streams and rivers used for recreational purposes and especially those on which water supplies for domestic use are dependent. In the advocacy of such areas it may be that the pendulum of enthusiasm for conservation has swung too far in one direction, but this is usually the case where reformers of any kind set out to warn the public of an approaching calamity. And it is not an exaggeration to state that if deforestation is permitted to continue on such areas, as it has done in the past, that it will have a calamitous effect on certain of the rural communities in southern Ontario at least.

This enthusiasm for the preservation of forests and the results which will acrue from them, particularly as regards water supply and stream flow, has occasioned a great deal of controversy between civil engineers, hydraulic engineers and others whose work brings them in contact wth the control and use of water, and the technical forester or forest engineer, as he is officially known in Canada.

It is not the intention of the present writer to enter into this controversy but simply to mention in passing that he is cognizant of the arguments on both sides and has "dipped into" the great array of articles which have been published on this subject. However, all agree that the forest does play an important part in connection with water resources and in this article an attempt will be made to show how this part can be strengthened by the wise use of existing forests on watershed areas and especially by the reforesting of new ones.

At the outset too, it would be well to state briefly what the aims of forestry are and what the work of the forest engineer includes. Forestry is the science or art of establishing, maintaining and harvest-

ing woodland crops for profit. In this is included the work of establishing new forests by reforestation, maintaining of forest areas by protection from fire, fungus, insects and other animals and the cutting of the trees when they have reached maturity. Its primary aim is to produce wood, but when one considers the type of soil and the topography of the country which are most suited to the growing of trees, it will be seen at once that it also includes the important subject of protection of watersheds, shelter for fur-bearing animals and the increasingly important rôle which the forest plays in connection with recreational interests and all that this means financially to a community.

While it is desirable in this paper to stress the need and value of reforestation, all such work when completed may be grouped with the present existing woodland on an area, and be considered in the one concept forest. For after all a forest is just as much a forest whether it be a few years old or a few hundred. The difference is in the size of the trees and the influence it has on an area, but the biological entity is the same.

Furthermore, the science of forestry is related to definite classes of soil. The forest engineer has no quarrel with the pioneer who cuts down trees on fertile soil for the purpose of establishing a farm. On the other hand, he does object strenuously to the clear-cutting of forests on land such as poor sand and gravelly ridges which can never become profitable farmland. The same is true especially of rocky hillsides with a thin mantle of soil or even steep hillsides of good soil, which form the headwaters of streams. It is these areas of absolute forest soil and submarginal lands which should be reserved for forestry and used to grow trees in perpetuity.

THE FOREST AND THE FOREST FLOOR

A forest has been described as "a plant society governed by definite natural laws the knowledge of which is basic to its intelligent management as an economic resource." If we examine an area of forest in vertical section what do we find? First of all we have the crowns of the trees with their dense foliage either broad-leaved in the case of deciduous trees, and needle-leaved in the case of coniferous. Here in the spring are the flowers and later on the fruit. Here too is a ramification of branches of all sizes supporting the foliage. Here through the leaves the work of transpiration and the manufacturing of food for the tree is carried on. Coming farther down we pass

through the larger branches most of which bear fissured or scaly bark in varying degree depending on the age of the tree. Reaching the ground we observe the roots which are composed of a growth similar in structure and development to the branches of the crown. These are the anchors of the tree, and through the root hairs at their extremities are the essential feeding parts of the tree. But the function of the roots does not end with giving support and nourishment to the tree, but in the act of extending themselves for food they open up the soil and make thousands of small channels into the ground which greatly increases its porosity. An extreme example of the power of trees to force their roots into the soil can be observed in the rocky areas of Ontario where quite frequently the roots wedge themselves into the rocks and force them to give way as the tree puts on girth.

The forest floor is perhaps the most important biological factor in the forest. It comprises all the growing plants up to a foot or so in height such as seedling trees, shrubs, trailing vines, both ligneous and herbaceous, a great array of wild flowers, moss and lichens depending on the type of forest. Beneath this is the accumulation of debris which has gathered throughout the life of the forest; made up of leaves, branches, bits of bark, cones and dead herbaceous growth in different stages of decomposition and pressed down by snow of many winters. This is the forest litter, grading into the humus or forest manure and becoming finer in texture until it mingles with the mineral soil.

This forest floor with its mantle of litter and duff of high absorption qualities is most important in regulating water movement on watershed areas. Not so much because it holds some precipitation in suspension to be given off gradually later on, but because it "maintains the absorption capacity of the underlying soil at its maximum."

It is in this layer that the clarifying process of water takes place, which is so essential where reservoir properties are concerned. Zon states that "The soil of the forest was found to contain less albuminoid matter and salts suitable for bacterial growth. Moreover, the humus produced by the growth of trees is inimical to pathogenic bacteria, which, up to the present time, has not been found in the soil of forests" (1929).

"It was shown that the soil has an important bearing upon the spread of cholera and typhoid fever. In India, it is claimed that villages surrounded by forests are never visited by cholera, and

troops are removed to barracks built in the forest to arrest the disease. Huffel confirms this by the statement that the town of Haguenau in Alsace, surrounded by a dense forest nearly 50,000 acres in extent, was always free from epidemics of cholera which in the last century attacked several times the other towns in the same district."

The assistance which the forest floor gives to the absorption of moisture by the soil is largely responsible for the feeding of springs and underground storage. Zon gives over thirty reliable references in Europe and on this continent, to increase and decrease of water in springs in relation to the presence of forest. As many references could easily be gathered in our own province from residents in the rural districts. No one, who has lived in wooded areas of Ontario and has watched the forest being cut down over large areas, will gainsay the fact that the water supply in springs has been changed.

SOILS

For the purpose of this article soils may be grouped into four classes, namely, rock, sand, loam and clay.

Where the surface of the earth has been folded in the past so that the outcroppings of rock lie at a sharp angle at the surface or where surface rock takes the form of large rounded exposures, or even where limestone lies near the surface in loose layers, the forest plays an incalculable part in regulating water supply and the prevention of erosion. These rocky areas with their many fissures and sink holes feed innumerable underground streams and springs which in turn give back their water to other areas of lower elevation. To remove the mantle of forest humus and its supporting vegetation from such areas is surely provoking nature, for at the time of spring thaw or heavy thunder showers these rocky surfaces will shed water almost as quickly as a tin roof. Such areas represent the poorest class of absolute forest soil and at the southern base of the Laurentian shield, which reaches into the northern part of Old Ontario, they constitute a large proportion of the headwaters of our streams and rivers.

These rocky soils support such species as jack pine, red pine, white pine and hemlock with spruce and balsam on the better sites. Hard maple, yellow birch, basswood, poplar and beech make up the bulk of the hardwoods. An example of this type of forest is found in the districts of Muskoka and Parry Sound and the ability of this mixture of species on these rocky soils to regenerate itself is truly remarkable.

Sandy soil, with which is included gravel, offers less resistance to

seepage than any other soil. And even where the gradient is steep, if the forest cover is intact a great deal of water is absorbed. On the other hand, sand is fairly easily eroded by wind as well as water once the protecting cover is disturbed, and for this reason it must be carefully protected with tree growth.

Sand plains and gravely ridges are the natural home of pine. Where we see in Ontario to-day large acreages of sand land such as those represented by the Normandy Plains of Norfolk, Camp Borden in Simcoe and the ridge of tumultuous sand hills extending through the north part of York, Ontario, Durham and Northumberland; there in years past was the greatest activity in cutting pine lumber. Such soils besides supporting white and red pine grow white spruce, balsam and some hemlock while cedar and tamarack occupy the more moist sites. Of the hardwoods we find most of the well known species represented especially where the soil tends to loamy sand and on bench lands. Such species are, hard and soft maple, beech, birch, basswood, ash, red oak, cherry, elm, ironwood and poplar.

Coming to the loamy soils we find the species run more to the hardwoods which have already been mentioned and the pines peter out. In addition to the common hardwoods we also find such valuable species as walnut, especially on soils of good depth, butternut, sweet chestnut, the white oak group, and in more southern sections of the province lesser known species such as tulip, sycamore and gum.

Loam also has a high capacity for absorption, in fact, it has been shown that a cultivated loamy field either level or of gentle slope will absorb more moisture than a similar area covered with forest. On the other hand, however, loam is very easily eroded and a great deal of damage can be done on watersheds of such soil once the protective covering of vegetation is removed.

Clay soils are the most difficult to handle both from the standpoint of reforestation and control. On such sites the species found are mostly hardwoods while in northern Ontario a great deal of white and black spruce are growing on clay.

Because of its small particles and gummy nature clay has least power of absorption. Moreover, because of its fine texture it has a tendency when eroded to clog the natural water channels into the soil made by both living and dead tree roots. It erodes very easily and the damage caused by silt from such areas is frequently well

nigh irreparable. It is very difficult to control once the surface covering is disturbed and only by persistent planting, and the erection of mechanical barriers over many years can it be finally conquered.

PRECIPITATION AND RUN-OFF

We occasionally hear the statement "plant more trees and conserve the forest and we will have more water in our streams and rivers." Such a statement is only partially true and requires elaborating. Actually forests do not increase the gross amount of water given off by a watershed in relation to the amount of precipitation because this would preclude the use of any of the water by the forest itself. What the forest does, however, is to lessen the violence of a rain storm on a watershed, prevent the snow from melting too rapidly in the spring and, through the agency of the forest floor as already pointed out, hold the moisture for absorption into the soil for underground storage.

By mechanical interference trees are of great assistance in modifying the duration and severity of rainfall. The leaves and branches break the force of the rain. Some of it trickles down the trunks so that much of the water reaches the soil without violence. These same agencies also prolong the duration of rainfall because after a storm, water may continue to drip from the trees for many hours. In this way it has a much better opportunity of being absorbed by the soil.

Forests have a special influence in retarding the melting of snow. This varies of course depending on whether the stand is pure coniferous, pure hardwood or mixed, and the aspect of the site. A forest composed of pure spruce would be the slowest to melt and a stand with a northern aspect of any type would be the last in which the snow would disappear. The amount of snow-fall is an additional consideration as well as the prevailing climate, but there are cases not too far north where snow has remained in the bush for over thirty days after it had disappeared in the open.

Trees and other vegetation use a certain amount of water. Some of this is evaporated from the leaves and trunks, some is used in building up tissue but a great deal of the precipitation is absorbed by the soil mantle. What is left constitutes the run-off.

It should be noted here, however, that although forests use a certain amount of water, the period of greatest use is not at the period of greatest precipitation. In this part of the province the

growing period, when trees use most moisture, extends for about five months including the summer. The greatest amount of annual rainfall reaches us in the spring, fall and winter when the trees are dormant or semi-dormant. During this time, however, they are still exerting their beneficial influence with respect to water regulation.

Before leaving the subject of run-off, something should be said regarding the relation between forests and floods. Forest engineers have never claimed that the forest or reforestation will prevent floods. These are caused by excessive precipitation of either rain or snow, and the irregularities of rivers can be traced directly to the irregularities of precipitation. But the forest has a decided mitigating influence on floods. From what has already been said regarding the interference of rain by the trees themselves and the water holding capacity of the forest floor, it can be easily seen that here is a potent barrier to small flood conditions. But when the forest reaches the point of saturation and absorption into the ground is retarded, its work is completed and run-off in large amounts will commence.

The ability of any forest to mitigate floods depends also on local conditions such as geological formation, topography, the size of the watershed and the depth and kinds of soil covering it, the character of the streams, their shape, the presence of waterfalls and natural storage basins.

EROSION

Of all benefits which a forest exercises on a watershed area, other perhaps than the supply of wood, none is more important than the prevention of erosion. This, of course, is intimately connected with stream flow and excessive run-off; in fact one has a direct bearing on the other and cannot be considered separately. Wherever the topography of the country is at all hilly, erosion of the soil is a factor to be dealt with.

Climate plays a small part in this but such factors as steepness of slope and character of the soil, and especially surface cover, are most important. On rocky areas which have only a thin covering of soil at the most, persistent erosion will result in complete desolation of the area. When the soil consists of sand, loam or clay erosion can reach colossal proportions, not only by damaging the watershed proper, but also by depositing wide fanshaped layers of sterile soil on good land further down stream. A long catalogue of examples could be quoted, giving evidence of how rivers, harbours and reservoirs have been siluted up with eroded material of different kinds.

Different methods have been adopted for the prevention of erosion such as sodding, planting of grasses, shrubs and willows. Gullies have been filled with brush or covered with straw and leaves. Expensive engineering works of stone and log dams and wattle work have been carried out, especially in the mountains of France. Such works are only temporary, however, and should be supplementary to reforestation. In fact on very steep slopes where all ground cover has been removed, something of this sort must be done first before vegetation can be started.

This problem of erosion is of particular interest to engineers in charge of reservoirs because the sediment and the coarser detritus carried by rivers not only increase the stream volume but fill up the storage areas to such an extent that they may become useless. One large reservoir on the Pacific Coast has had fifteen percent of its storage capacity reduced by silt in seventeen years. Another on the east coast which lies below large cultivated areas in ten years was filled up leaving only a channel through the centre for the water to flow.

Critics of reforestation will claim that other types of vegetation such as shrubs and grasses of different kinds are just as beneficial for the prevention of erosion as trees and even where the forest has been cut down on a watershed that the remaining vegetation will sufficiently regulate run-off and prevent erosion just as well as before the forest was cut down. This is true to a certain extent, although it does not credit the forest with giving additional shade which in turn offsets evaporation, to say nothing of its future economic value in wood products. Of all vegetation, forests are the most efficient for preventing hillsides from eroding and filling up beds of streams with silt. Even on soils of high absorption capacity where the storage of water may be secondary, forest cover is essential as a protection against erosion. Moreover, where it is necessary to protect such areas with vegetation it is cheaper to produce and plant trees than shrubs.

Just here it would be well to state some of the causes which are responsible for severe erosion. The most important of these are forest fires. A forest fire not only injures the large trees if it does not kill them outright, but destroys the forest floor with its capacity for holding water. In fact, in rocky areas, the very soil itself may be burned off which will require hundreds of years for replacement on the part of nature. Faulty methods of lumbering, which very fre-

quently are followed by fire, is another contributing factor. On protection forests which occupy hilly country no clear-cutting should be permitted. On some of the steeper slopes it is questionable whether any trees either standing or down should be removed at all. No cutting should be done which in any way would interfere with the mantle of forest litter, thereby opening channels for erosion. Unwise agricultural settlement should also be mentioned. This applies chiefly to hilly areas of land of low agricultural worth such as sand and gravel. The cultivation of such hillsides adjacent to streams increases the body of silt and even pasturing has a tendency to disturb the thick turf which holds these areas from being eroded by wind as well as water.

MUNICIPAL FORESTS

As already stated at the beginning of this paper forests which are established by reforestation, or are natural woodland, and which occupy country from which water is obtained for domestic purposes, are usually spoken of as protection forests. And while their maintenance is very essential to a controlled amount of water and the prevention of erosion, nevertheless there is no reason why they should not be considered in the dual capacity of reservoir protection and a municipal forest. In a complete scheme for the control of such streams the areas to be acquired may extend for many miles into the country, and where dams and reservoirs must be established to control flood conditions more land will have to be bought than can actually be used for water storage only. Such areas would be the crest of hills, small gullies which contribute run-off and particularly odd pieces of good agricultural land which would be in excess of properties actually needed but would have to be included when purchasing the major part of a man's holdings. These are the areas which could be reforested and incorporated into a municipal forest.

This idea of municipal forests is not a new one. It has been carried on for hundreds of years in Europe with a great deal of success and profit and during recent years extensive areas of non-agricultural land and watershed areas have been planted for this purpose in the United States. H. F. Prescott of the State of New York Conservation Department states in his publication "Municipal or Community Forests";

"The average net profit from European town-owned forests is given by J. H. Foster, state forester of New Hampshire, at $5 an acre and many com-

munal forests in Switzerland yield an annual net return of $8 an acre. In Zurich, Switzerland, there is a city forest that has been under forest management for over 1,000 years and yields a net revenue yearly of from $20,000 to $30,000 which is at the rate of $4.70 to $7 per acre per year. Another illustration of the value of a municipal forest, noted by the same authority, is furnished by the village of Orson, Sweden. The people of this town are tax free and have free street car service, telephone, library, schools, etc. In Germany, one town uses a portion of its forest to meet extraordinary expenses for public improvements. In place of issuing bonds for a new school house, public building or other municipal improvements, the town cuts sufficient timber from the reserve section of its forest to meet the cost. In many towns and cities in Switzerland and other European countries, the revenue from the municipal forest pays all the local taxes.

In the United States, municipal forests are still too young to supply any data as to the financial returns which may be expected from them, but it is possible to give an illustration of what one small planted forest actually returned to its owner when cut at the age of 48 years.

At East Bridgewater, Mass., in the early seventies, a young man planted a tract of slightly less than 12 acres with small pine trees that he dug up from the neighboring fields and pastures. In 1921 the trees were sold to make shoe boxes for the neighbouring city of Brockton, the owner of the plantation receiving $10 a cord for the lumber on the stump. The forest was cut clean, yielding 589 cords of box lumber worth $5,890 on the stump, or a trifle less than $500 an acre. New York State conditions for growing white pine are sufficiently in accord with conditions in Massachusetts to make this illustration of forest returns applicable to this State after making due allowance for accessibility to a market. Several cities in New York State already have planted forests of more than 1,000 acres and a number of others have planted 500 acres or more and are enlarging these forests from year to year.

The primary purpose of most of the municipal forests now in existence in this State is watershed protection rather than revenue, but many of the plantations are rapidly approaching the age when they should be thinned for the improvement of the stand. The marketing of the material removed will help pay the cost of maintaining the forest."

In 1935 New York state planted nearly 53 million trees, several states planted over 10 millions. Michigan tops the list with nearly 113 millions while the total for the whole country in this one year was 501,789,763 trees. Most of this work was done by the Civilian Conservation Corps which included upwards of 250,000 unemployed youth of the country.

In Canada the province of Ontario has the largest program of tree planting and municipal forests, and during 1935 planted and distributed 10 million trees. Ten counties have commenced one thousand acre municipal forests and several townships and towns have smaller areas. Several municipalities have planted trees in

connection with their reserovir properties; notably among these are St. Thomas, Guelph, Hanover, Beeton, Woodstock, Orangeville, Midland and a few others with smaller areas. The city of Fort William has a splendid example of a natural protection forest surrounding Loch Lomond from which the city obtains its water supply.

From the foregoing it will be seen that there is an intimate relationship between reforestation and water resources, but this relationship is supplementary.

Reforestation will not increase the gross water supply on a small area nor is it intended to take the place of other engineering projects, but it is a supplement of such importance that no complete plan for water supply obtained from watersheds or the control of floods should be undertaken without it.

(*Presented before the Canadian Section meeting, April 1, 1936.*)

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FREEZING TROUBLES IN INDIANA

(As Reported At The 29th Annual Meeting of The Indiana Section, Lafayette, Indiana April 7-8-9, 1936)

Place	Frozen meters: Pits	Frozen meters: Basement	Frozen meters: Total	Frozen meters: Per cent	Frozen services: Number	Frozen services: Per cent	Normal cover, inches: Mains	Normal cover, inches: Services	Inspection of service cover	...protection ...meters
Bedford	50	240	290	7.5	879	23	30	28	No	No
Bloomington	300	100	400	9	600	13	36	30	Yes	...meter
Columbus			75	12	275	9.17	48 to 72	18 to 48		
Crawfordsville	177	138	315	12.1	276	8.7	42	36	Main to p.l.	...meter
Danville	50	10	60	9+	230	35+				
Elkhart	15	30	45	.0055	400	4.9	60	54 to 60	Neglected	...ens a...
Evansville	1,054	181	1,135	4.9	684	2.7	36 to 48	24 to 48	Yes	No
Ft. Wayne			1,244	4.4	2,500	8.8	48 to 54		Main to p.l.	No
Galveston	4	2	44	26	50	33⅓	40	30	No	No
Gary	None in serv.	1,100	1,100	7.76	315	2.11	66	66 to p.l., 48 p.l. to hse.	No	...s and ...
Goshen	6	225	231	7.5	325	10.5	54	60	No	...ric heat
Indianapolis	1,446	3,653	5,099	7.0	2,000	2.75	50	54	Yes	No
Jasonville	26	0	26	14	26	14	30	30	Yes—30"	No
Kendallville	20	70	90	5	35	2	60	30 to 60	Yes	Pack
La Porte	8	25	33	2.75	100	3	60	54	No	No
Ligonier	22	4	26	3	25	3	54	48	No	No
Marion	713	25	738	12.3	75	1.2	60	40	Yes	...se pits
Michigan City	41	186	227	4.3	517	9.7	54	42 to 48	No	No
Newburgh	22	0	22	7	35	20	22	18 to 20	No	...se pits
Noblesville	125	25	150	12.5	327	25	44 to 53	38 to 40	Yes	
Osgood	67	0	67	31.1	67	3.3	20	20	Yes	
Richmond	66	246	312		55	0.6	54	48	Yes	...ecomme...
Rochester	55	21	76	6.5	62	6	54	48	No	No
Rockport	0	0	0	0	10	1.5	36	36	Yes	...se pits
Scottsburg	2	0	2	1.5	1	.002	36 to 42		Yes	...se pits
Terre Haute	1,210	210	1,420	11.4	30	0.2	48 to 54	48 to 54	No	...m at mo...
Union City	122	12	134	10	280	17	48	30	Past 6 yrs.	No
Valparaiso	0	100	100	5	150	7.5	48	48	Yes	No
Washington	170	20	190	10	280	10	54	30	No	...b. speci...

ANA TOND CITIES FOR WINTER OF 1935-36

NA SECTIOHE AMERICAN WATER WORKS ASSOCIATION AT PURDUE UNIVERSITY,
, 1936) (TED BY INDIANAPOLIS WATER COMPANY)

NSPECTION OF SERVICE COVER	PROTECTING TERS	FROST PENETRATION, INCHES: Sandy soil	Clay soil	PUMPAGE INCREASE ON ACCOUNT OF WATER WASTE	WAS SERVICE INTERRUPTED	ANY TASTE OR ODOR—REMEDY	FROZEN MAINS	FROZEN HYDRANTS	MAIN BREAKS ACCOUNT OF FREEZING
No	No		36	8 m.g. for Feb.	No	No	3	38	7
Yes	meter pit		42	0.5 m.g.d.	No	Yes—Carbon	2	10	1
			48	100%	Almost	Yes—Carbon	3		137 serv. brks.
ain to p.l.	meter pit		48	50%	No	Yes	0	7	0
		40	40	100%	No	No	Few	0	0
Neglected	ms and cover	60		100%	No	Yes—Flushing	11	5	50
Yes	No	36	36	132.56 m.g.	No	No	2280′ of 2″	None	None
ain to p.l.	No	54	48	4.02 m.g.d. for Feb.	No	Yes—Carbon	31	100	31
No	No		36	3 times normal	No	No	None	None	None
No	Sx and sawdust	54	60	1000 g.p.m.	No	No	None	None	None
No	ric heater	54	60	7%	No	No	1	6	None
Yes	No	50	48	15% to 20%	No	Slight—Ammonia, carbon	24	6	19
es—30″	No		30	25%	No	No	1	0	3
Yes	Pack	40	40		No	No	0	2	0
No	No		54	25%	No	Yes—Chlorine	5	0	5
No	No	60	54	70%	No	No	2	3	1
Yes	se pits	40	30	No	No	No	1	4	0
No	No	63		3½ times normal	No	No	3	12	3-92 serv.
No	se pits	30	30	25%	No	No	4	1	27
Yes		48		50%	No	No	9	15	5
Yes		37	28	6,000 to 24,000 g.p.d.	Yes—main break	No—Used carbon	3	3	8
Yes	ecommended		45	500,000 g.p.d.	No	No	1	0	1
No	No	52	50	7%	No	No	5	2	5
Yes	se pits	32	30	Yes	No	No	1	0	0
Yes	se pits		24	20%	Yes—main break	No	2	0	2
No	n at meter	60		20%	No	Yes—Carbon	3	1	1
. 6 yrs.	No	54	48	25%	No	No	3	3 branches	4
Yes	No	54	48	1.5 m.g.d. excess	No	No	8	15	50
No	. specifies lo-	30	22	40%	No	Slight deviation	0	0	0

J. A. BRUHN,
Secretary

FLUORIDES IN THE NATURAL WATERS OF RHODE ISLAND

By W. George Parks, Maryanne Robinson and Marjorie Law

(*Department of Chemistry, Rhode Island State College, Kingston, R. I.*)

The first reference to mottled enamel of teeth was made by Eager (1) in 1901. Since then many articles have been written and much research work has been done on this subject (2, 3, 4, 5, 6, 7, 8). Churchill (3) indicated that the presence of fluorides in the drinking water might be the cause of the trouble. The continued ingestion of fluorides during the period the teeth are being formed appears to cause the enamel to become paper white and opaque in contrast to its normal yellowish and translucent appearance. This condition is found over large areas in southwestern United States, as well as in England, Africa and elsewhere (5, 6, 7, 8, 9, 10). Bauxite, Arkansas, and Oakley, Idaho have discarded water supplies in favor of others containing less fluorides (5), and other cities are considering similar action. The town of Chetopa, Kansas is being sued by the parents of children whose teeth have been damaged (11). The work of McKay (12), Smith, Lantz and Smith (4), and others have definitely confirmed the fact that fluorides cause mottled tooth enamel. Consequently, many surveys have been made covering different sections of the country. This situation, connected with the fact that very little is definitely known concerning the fluoride content of Rhode Island waters, led us to initiate this investigation. However, this is strictly a chemical study, no attempt has been made to correlate the presence or absence of mottled teeth with the fluoride content of the waters examined.

EXPERIMENTAL

After a thorough investigation of the numerous methods found in the literature we believe that there are two colorimetric methods especially applicable to the determination of the small quantities of fluoride (0 to 15 mg. per liter) found in natural waters. The first method is that reported by Sanchis (13) where the quantity of

fluoride present is estimated by the intensity of color produced with the indicator alizarin sodium sulfonate. Standard colors are prepared against which the unknown solution is compared using either

TABLE 1

Fluoride analyses of Rhode Island waters

LOCATION*	FLUORIDE IN SAMPLE
	p.p.m.
Block Island	0.24
Bradford	0.20
Cumberland	0.21
East Greenwich	0.21
East Providence	0.22
Esmond	0.20
Exeter	0.22
Georgiaville	0.23
Glendale	0.26
Harrisville	0.17
Jamestown	0.16
Kent Dam	0.21
Kingston	0.19
Middleton	0.20
Newport	0.16
North Scituate	0.20
North Tiverton	0.18
Oakland Wostered	0.22
Pascoag and Harrisville	0.15
Pawtucket	0.20
Pawtuxet Valley	0.18
Peace Dale	0.23
Slatersville	0.20
State College	0.19
Wallum Lake	0.22
Warren	0.20
Warwick and Coventry	0.18
Westerly	0.22
Woonsocket	0.17

* Complete analyses of these water supplies may be obtained from the Report of the Rhode Island Public Health Commission.

Nessler tubes or a colorimeter. In our work we employed both methods in order to serve as a check on the results. Sulfates, phosphates, organic matter, and some of the metals if present in

quantities greater than a few parts per million interfere with the color matching. A special procedure must be employed in this case. If the standards are treated in a manner identical to that of the unknowns the fluoride in the sample may be estimated to the nearest 0.1 p.p.m. by interpolation. This method was found to be reliable, convenient and especially suited to routine determinations when a large number of samples are to be analyzed at any one time. Smith (14) also found this method superior to several others.

The second method is that of Armstrong (15) where the fluoride is estimated by the amount of fading produced in a standard ferric acetylacetone solution. The influence of certain other salts and the acidity of the solution is eliminated by determination of the fading caused by the fluoride in an aliquot of the solution, followed by a measurement of the fading produced by an equal aliquot to which has been added a known quantity of fluoride. Sodium sulfate, chloride and nitrate if present in large quantities interfere with the fading action. The results obtained by this method checked those of the previous method to better than $\pm$ 0.1 p.p.m.

During the spring and summer of 1935 samples of *untreated* water were secured from representative water supplies throughout the state. Duplicate analyses were carried out using both methods previously mentioned. The results obtained are summarized in table 1.

DISCUSSION

Boissevain (16) believes that fluorite bearing granite is the source of the fluoride present in natural waters and the presence of 1 p.p.m. will produce spots on the teeth. However, McKay (17) places the danger line at 2 p.p.m. with 0.6 p.p.m. capable of spotting the teeth. Rider (18) agrees with Boissevain in finding that for children of susceptible age 0.9 to 1 p.p.m. will cause mottled enamel. There is some disagreement in the literature concerning the quantity of fluoride necessary to have harmful effects on the teeth. The majority of authorities place the dividing line at 1 p.p.m. If this is true the data in table 1 indicate that the quantity of fluoride present in the natural waters of Rhode Island is without significance. From the general information available concerning New England waters the fluoride content should be very low. Our results support this fact. Many waters from western areas vary from 5 to 8 p.p.m., and cases are known in which it is as high as 16 p.p.m. Various methods

(19, 20) for removing fluorides from drinking water have been suggested. They are not entirely satisfactory, but treatment of this sort is not necessary in Rhode Island at the present time.

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REPORT OF THE COMMITTEE ON NATIONAL WATER POLICY

Your Committee on National Water Policy was appointed in May, 1935, at the Cincinnati Convention. Its activities during the past twelve months have been concerned largely with participation in those enterprises in which the Federal Government has been active.

These activities may be roughly divided into two types, the first covering negotiations and discussions with the Water Resources Committee and the Water Planning Committee of the National Resources Committee and the second, with legislative hearings on aspects of water supply with which this Association is concerned.

DISCUSSIONS WITH FEDERAL AGENCIES

At the invitation of the National Resources Committee, to the Committees on National Water Policy of the American Water Works Association and of the American Society of Civil Engineers, members of these Committees met in Washington on January 22, 1936, with members of the former Water Planning Committee and the present Water Resources Committee, for joint conference on water planning policy.

The American Water Works Association's Committee on National Water Policy appointed pursuant to a resolution at its Annual Meeting in May, 1935, was represented by Messrs. Abel Wolman, of Baltimore, Md. (Chairman), Howard S. Morse, of Indianapolis, Indiana, and Samuel B. Morris, of Stanford University, California. Representatives from the American Society of Civil Engineers' Committee, which was appointed on resolution adopted at its 1935 Fall Meeting, were Messrs. LeRoy K. Sherman, of Chicago, Ill. (Chairman), Donald M. Baker, of Los Angeles, California, Lawrence M. Lawson, of El Paso, Texas, and Arthur D. Weston, of Boston, Mass. Col. Herbert S. Crocker, of Denver, Colorado, and Mr. Charles S. Paul, of Dayton, Ohio, represented the former Water Planning Committee of the National Resources Board.

The Conference was opened by Mr. Charles W. Eliot, 2nd, Executive Officer of the National Resources Committee, with a brief statement

of the responsibility assigned to the Water Resources Committee for devising technique in water planning, both in assembly of adequate facts, and in development of a National plan and program. Members of the Committee then presented phases of its past and proposed work.

"A Declaration of Principles" based on the work of the Mississippi Valley Committee and the former Water Planning Committee was presented by Professor Harlan H. Barrows, of the University of Chicago. In brief form, these are:

A coördinated, unified National Policy is needed; the constituent parts of such a policy which relate to various water uses or controls must be mutually consistent.

All planning under such a policy should be primarily concerned with people, not with water per se.

In most cases, a given drainage area should be treated as a unit with respect to its water problems.

A river-basin water plan must be based on thorough study of adequate data on all phases of the interlocking cultural and physical problems of the region. Occasional modification of any long-term plan will be necessitated by unforeseeable events and developments.

Systematic collection of fundamental data on surface and ground waters should be promoted by all possible means.

The cost of executing plans for use or control of water should generally be distributed in accordance with distribution of benefits. A suitable technique is most urgently needed for the allocation of joint costs in multiple-purpose projects; and for evaluating indirect and intangible benefits from a project.

Closer coördination of activities of Federal agencies dealing directly or indirectly with water problems is desirable; and closer coöperation between Federal, regional, State, and local agencies with respect to water problems is imperative.

A permanent National water-planning unit is needed as a coordinating agency which in coöperation with appropriate Federal agencies shall provide to interstate, state and local agencies desiring it the scientific and technical advice and guidance which will aid them in solving their own problems. Enlightened public opinion and sentiment are necessary to the success of a water policy.

A National water policy, however admirable in theory, will be utterly useless in a practical sense until embodied in plans which are put into action.

The organization and work of the present Water Resources Committee was described by Lt. Col. Glen E. Edgerton, Corps of Engineers, U. S. Army. He described the composition of the Committee; eight members representing Federal agencies having specialized knowledge and official responsibility in the field of water resources, two members representing State agencies similarly qualified, and two members not connected with other governmental agencies but especially qualified by connection with the earlier Committees.

Mr. Thorndike Saville, Dean of the College of Engineering, New York University, presented in more detail the work of this Committee and its predecessors toward basic data for water planning. He described the Inventory of the Water Resources of the United States, published as Part III of the December, 1934, Report of the National Resources Board, and the reports of the Regional Water Consultants on which it was based; the program of specific research and data collecting projects developed by the Water Resources Section and which were sponsored to the National Emergency Council for allotments as fundamentally necessary to sound water planning; and described the recently published U. S. Geological Survey Water Supply Papers giving the result of research studies on floods and on rainfall-runoff relationships. He noted that private practitioners generally approve the collection of basic data by Federal agencies, but do not so generally approve of their engaging in research; and commented that the research studies just noted could hardly have been undertaken or produced by other than an agency of the Federal government on account of their cost.

Mr. Abel Wolman, Chief Engineer of the Maryland Board of Health and Chairman of the Water Resources Committee, concluded the description of the Committee's work with an outline of its objectives,—promotion of collection of adequate basic data and factual knowledge; coördination of the activities of Federal, State, and local agencies in water planning; and the development of a planned National program of water use and control; with the incidental disclosure of priorities among desirable projects. He called attention to the two major changes in policy since 1933; first, larger emphasis on the use of existing Federal and State agencies; and second, increasing thought toward a long-term plan and less on emergency projects. He stressed the value of slow-motion, deliberate action, and the urgent need of a rational policy in distribution of costs prior to initiating large projects; both as to costs assigned to the several

functions of a multiple-purpose project, and the costs to be assigned to the several levels of government for equitable assessment against the beneficiaries.

The visiting conferees successively led discussion of various aspects of a National water policy, the extent to which Federal leadership is desirable, and means of bringing technical and professional associations into most effective coördination. The consensus of opinion resulting from the conference is summarized as follows:

A central agency is needed to develop plans and programs in the broad public interest which must be broadly planned and effected. Harmful situations, difficult to correct, are locally developed; harmonization in the early stages is far easier than after heat and violent feeling are engendered. The responsibility for corrective action should be left to the States; Federal assumption of financial responsibility is not justified. Present agencies are not succeeding in enlightening and educating public opinion to the point of recognizing and assuming the responsibility; Federal fact-finding and advisory leadership in corrective planning is necessary. State and local tolerance of Federal advice and administration must be expected to be based on provision of Federal funds in aid.

The visiting conferees were united in opposition to centralized Federal administrative authority; one cited violations of State Sanitary standards by badly informed Federal constructing agencies in support of his mistrust. A central Federal water planning agency should, they believed, not become a directing or constructing agency, and not primarily concerned with project development; but should stimulate data collection and research, and coördinate water planning and policy making.

In the field of data-collection and research, they believed that the Federal planning agency should not act independently, but should stimulate extension of the work of the regularly constituted agencies through allotments to them for services to meet specified requirements. Both of the visiting Committees on National Water Policy adopted resolutions recommending the Water Resources Committee as the agency to stimulate and provide funds for continuance of research studies for water planning, such as the recently published report on floods, U.S.G.S. Water Supply Paper No. 771.

In the field of planning and policy-making the visiting conferees were in general agreement that large emphasis should be placed on State and local planning, and that a central Federal planning agency

can best secure popular acceptance of broader and more far-sighted principles through stimulation and guidance of State and local planning agencies. The central agency should continue to concern itself with clearly defining problems and their broader implications, and thereby guard against waste of local effort in attacking problems too narrowly. The value of many of the State Planning Consultants in holding consideration to the main problem rather than to technical minutiae was recognized. It was generally agreed that it should be a principal concern of the Water Resources Committee to broaden and strengthen its working contacts with planning agencies in the States, and to keep individuals and associations principally concerned with water resources currently informed of its work and objectives.

Mr. L. K. Sherman, Chairman of the Committee from the American Society of Civil Engineers gave it as his judgment that the immediate requirements toward a National water policy are: (1) determination of the proper division between Federal and State authority and jurisdiction as to construction, maintenance, and operation of water utilization works; (2) determination of the proper allocation of costs of such works between Federal and State (including local) governments; and (3) Study and planning, by basins and regions with local agencies, as to plans and programs of desirable works and their relative costs and merits. He named six water uses and seven types of water control. These, when considered together with reference to any project, and with full regard for tried and successful divisions of State and Federal powers and duties, appeared to him to make it possible to set up a consistent allocation as between Federal and State governments.

The visiting Committees on National Water Policy expressed their desire to coöperate constructively with the Water Resources Committee; working generally by correspondence through their Chairmen, and giving their judgment on papers and matters referred to them by the Water Resources Committee.

APPEARANCES BEFORE LEGISLATIVE COMMITTEES

During the last twelve months a number of important acts have been introduced into the Congress dealing primarily with the increasing problem of the control of water pollution. As a result of this interest, it was necessary for your Chairman to appear before a series of committees of both the House and the Senate of the United States Congress.

On February 27, 1936, your Chairman appeared before the Wild Life Committee of the House under the Chairmanship of Congressman Robertson of Virginia. This appearance was made at the request of the Committee to discuss the general problem of pollution of streams and the methods proposed for controlling the difficulty. The attitude of this Association as well as of other interested groups in the United States was discussed at considerable length with the members of the Committee, in order to make clear to them the important character of the problem, the many complexities involved, the difficulties in Legislative control, the dangers of too extended centralization and the opportunities for improvement in this field with adequate central stimulation and coördination.

Upon the introduction of Senate Bill 3958, by Senator Lonergan of Connecticut, on the control of water pollution, your Chairman was requested to appear before the Senate Commerce Committee, under the Chairmanship of Senator Copeland of New York City. The hearings on this particular legislation were presided over by Senator Caraway of Arkansas.

Your Chairman made his appearance on March 23, 1936, and reviewed before the Senate Committee similar issues already discussed before the House Committee on Wild Life. He presented further an analysis of the Act proposed by Senator Lonergan and pointed out the major deficiencies therein. The involved character of the legislation proposed by Senator Lonergan was particularly emphasized inasmuch as it included administrative, appropriating and regulatory provisions which would be quite impossible for one agency to enforce. Furthermore, it delegated to the National Resources Committee, a planning and coördinating agency, administrative duties of such detail as to vitiate entirely the functioning of the National Resources Committee.

The Lonergan act appeared to be unwieldy, impractical and an unnecessary extension of Federal powers.

On May 21, 1936, your Chairman appeared once more before the Sub-Committee of the Senate Commerce Committee to discuss the merits of a new water pollution act introduced by Senator Barkley of Kentucky.

This bill provided for the creation of a stream pollution control division in the U. S. Public Health Service to which powers would be delegated for investigation, coördination and stimulation of activities in this field. The act further provided for grants-in-aid to local

areas for sewage treatment purposes, upon the approval of the Secretary of the Treasury and upon the recommendation of the Surgeon General of the U. S. Public Health Service.

This proposed act apparently meets the criteria for reasonable Federal legislation which the Advisory Sub-Committee of the National Resources Committee on Water Pollution had established in 1934.

At this hearing your Chairman indicated these conclusions and suggested that the American Water Works Association stood in agreement with these proposals. It is important to point out, furthermore, that the State and Territorial Health Officers of the United States have also reviewed and approved the legislation proposed by Senator Barkley.

Its passage would mark the first step in an orderly attack on the water pollution control problem.

On May 29, 1936, your Chairman discussed the same legislation before a Governors' meeting in Washington, at which the Governors of the various Ohio River states were present.

The proposed activities of the Committee on National Water Policy for the future cannot be presented at this time, since their character will depend to a considerable degree upon the problems which arise both locally and nationally in this important field.

The Committee requests that this report be accepted and that the Committee be continued at least for another year.

Respectfully submitted,

L. R. Howson,
T. A. Leisen,
S. B. Morris,
H. S. Morse,
Abel Wolman, *Chairman.*

Committee on National Water Policy.

WATERSHED PROTECTION AND CONTROL

By G. M. Irwin

(City Engineer and Water Commissioner, Victoria, British Columbia, Can.)

The protection and control of watersheds may be treated under two heads, namely:

With reference to the steps that can be taken to keep the water on the watershed from becoming contaminated in any way; secondly, with reference to the conserving and thereby increasing the quantity of water that can be obtained from a particular watershed.

As an example of an endeavor to keep the water on a watershed pure, I shall describe how this is done at Victoria, British Columbia, Canada, where the waterworks system is owned by the Corporation of the City of Victoria, and supervised by a Water Commissioner acting under a City Council.

WATERSHED RESTRICTIONS

The City owns two gravity systems. The watershed area of one is 30 square miles and of the other 11.2 square miles. These areas are owned by the City.

No one is allowed on the City's watersheds without permission, which is obtained as follows: The applicant sees the Water Commissioner and explains why he wishes to go upon the watershed. He then sees the City Medical Health Officer who asks him:

1. Why he wishes to go upon the watershed.
2. If he has ever suffered from typhoid, paratyphoid fever, cholera or dysentery.
3. To go to a hospital for a blood test to show that the blood does not react to typhoid fever by the Widal test. In connection with this the Medical Health Officer uses three certificates, designated "A," "B" and "C." The following are examples of them:

"A" Certificate

I hereby certify that, in my opinion Mr. John Jones proceeding to the Sooke Lake Watershed, for the purpose of visiting the Caretaker, is free from any communicable disease.

Date:

Signed by Medical Health Officer.

"B" Certificate

I hereby certify that Mr. John Jones, employed by the Fairservice Logging Company on the Goldstream Watershed, has given a negative Widal reaction.
Date:

Signed by Medical Health Officer.

"C" Certificate

I hereby state that, to the best of my knowledge, I have never suffered from typhoid, paratyphoid fever, cholera or dysentery.

Signed by Applicant.

Note: Anyone who has had any of the above mentioned diseases may apply to the City Health Officer for examination as to freedom from such disease, or from the "carrier" condition of such disease. Such examination and certificate of the result thereof, shall be at the discretion of the City Medical Officer of Health.

The City Medical Health Officer on being satisfied that there is no sanitary reason why the applicant should be kept off the watershed advises the Water Commissioner, who writes a letter to the Council asking for its approval. After the Council passes a resolution of approval the Water Commissioner signs a permit, which when attached to certificates "A," "B" and "C" allows the applicant to go upon the watershed.

The following is a copy of the Act dealing with this and also a copy of the Health Act referred to in said Act

Section 8 of "Victoria City Act, 1930" deals with un-authorized entry upon watershed. Section 8 reads as follows:

"Notwithstanding the provisions of the Trespass Act or of any other statute or law to the contrary no person shall enter upon any watershed land or other land owned or controlled and held or used by the Corporation for waterworks purposes or in or upon any of the waters located within the area of the said land without the consent or authority in writing of the Water Commissioner with the approval of the Council of the Corporation expressed by resolution thereof; and any person so entering upon the said land or waters as aforesaid without the said consent or authority shall be guilty of trespass and shall on summary conviction be liable to a penalty not exceeding Five hundred dollars ($500.00) and not less than Ten dollars ($10.00) for each such offense and in default of payment to imprisonment for a period not exceeding three months:

Provided, however, that the foregoing provisions of this section shall not apply to any public highway used for vehicular traffic within the area of the said watershed land:

Provided, further, that the Council may from time to time by by-law exclude from the operation of the said foregoing provisions of this section any portion or portions of the said lands and waters that in the opinion of the said

Council are not likely to be injuriously affected for waterworks purposes by entry as aforesaid.

PROVIDED, further, that this section shall be subject to the mining laws of the Province; and provided, further, that nothing in this section shall be deemed to authorize the doing of anything which shall at any time render any portion of the said land or water referred to in any such by-law unavailable or unfit for waterworks purposes, nor in any way to alter, impair, or affect the provisions of section 35 of the "Corporation of Victoria Waterworks Act, 1873."

PROVIDED, further, that every person authorized to enter upon said lands or waters shall comply with all sanitary regulations governing watersheds under the "Health Act."

PROVINCE OF BRITISH COLUMBIA

HEALTH ACT

SANITARY REGULATIONS GOVERNING WATERSHEDS

These regulations shall be applicable to every person entering upon any watershed area above or beyond a municipal intake, reservoir, or dam.

1. (*a.*) Watershed Sanitary Inspector or Inspectors shall be appointed, subject to the approval of the Provincial Board of Health, by the City or Municipal Council concerned.

(*b.*) Watershed Sanitary Inspectors shall have full authority to enforce these regulations. They must reside upon the area under their supervision. They shall not be absent from the watershed for a period of more than twenty-four hours per week without the sanction of the local Medical Health Officer or Chief Provincial Sanitary Inspector.

(*c.*) The Inspectors shall order the liberal use of quicklime or other disinfectant when and wherever needed.

(*d.*) The Inspector shall send a written report of the watershed conditions under his charge to the Provincial Board of Health and a copy to the local Medical Health Officer not less than every two weeks.

(*e.*) The Provincial Chief Sanitary Inspector shall make periodical visits to see that these regulations are being enforced, and shall have power to change or add to these regulations according to nature of industrial operations and changing conditions or emergencies. Such changes must be subject to the approval of the Provincial Board of Health.

(*f.*) Operators shall provide food and shelter for visiting authorized Inspectors when upon the watershed.

2. All officials and employees of companies operating in the watershed shall produce to the Inspector a certificate from a licensed medical practitioner that they are not affected by any disease which, in his opinion, would pollute the water.

3. (*a.*) Certificates of health, successful typhoid inoculation, or Widal test certificate must first be produced before any person will be permitted to work for the company, in any capacity, above the city's intake.

(*b.*) Certificate shall state: (1) That he is not suffering now from any communicable disease; (2) that he is not a "carrier" of typhoid fever, diphtheria, or scarlet fever.

4. (*a.*) All persons entering the watershed for whatever purpose, other than officials and employees of the company, must first submit themselves to a blood test (Widal) and certificates of health must state: (1) That the blood test is negative; (2) that he is not suffering from any communicable disease; (3) that he is not a "carrier" of typhoid fever, diphtheria, or scarlet fever.

(*b.*) No person will be permitted to enter the watershed above the intake without first presenting the aforementioned certificate of health to the Inspector in charge.

5. All persons entering upon watershed area must satisfy the Sanitary Inspector in Charge that they are provided with the necessary equipment and convenience to safeguard the watershed area from contamination.

6. Instructions and rules on sanitation of camps to be posted in all camp buildings in a conspicuous position.

7. *Camps*—The location of all camps to be subject to the approval of the Provincial Board of Health and the local Medical Health Officer after consultation with the manager of the interested company.

Arrangements must be made for safe and thorough disposal of garbage, refuse, tins, etc., or else remove same to an incinerator.

All liquid waste, slop-water, etc., from the cook-houses, bathing-houses, laundry, etc., must be run in pipes, or by other means acceptable to the Inspector, into a properly constructed tank and chlorinated or otherwise treated so as to effect sterilization.

Every camp shall be equipped with a wash-house and laundry containing a stove, tubs, and facilities for drying; also wash-basins, shower-baths, soap, and all proper sanitary facilities to the approval or the Inspector. Cleanliness, of course, is necessary for the health of the men and it must be insisted upon. Persistently unclean persons will be debarred from the watershed.

Bathing or laundry-work in the creeks or streams is absolutely prohibited.

All cook-houses, dining-rooms, etc., to be screened to prevent the entrance of flies.

Meat-houses and store-rooms must be flyproof and built to the satisfaction of the Inspector.

All bunk-houses must be built with adequate light and ventilation, the interior limewashed or painted and fitted with iron bunks.

Plans and specifications of all buildings to be erected to be furnished in duplicate to and approved by the Provincial Board of Health.

8. *Latrines.*—Deep pit not less than 8 feet by 30 inches, lime-treated daily, to be filled in with earth or gravel when contents reach within 2 feet of surface; or a pail system of galvanized-iron pails with covers, which can be easily handled and removed to the incinerator. The location of any latrine must be selected by the Inspector in Charge.

Chlorinated or quick lime must be available at all latrines and all latrine cans must have liberal daily allowance when in use.

When necessary to install urinals on work away from latrines, soak-aways must be provided and constructed under approval of Inspector in Charge.

For all persons engaged or employed above the intake, where the work is not convenient to camp latrine, the pail system must be used and removed daily to the incinerator. Any man found not using these pails must be instantly discharged.

All roads for rail-cars, trams, trucks, or other vehicles must be constructed and drained in such a manner as not to pollute any watercourse or stream.

Maps of the property shall be furnished to the Provincial Board of Health and the municipalities concerned, showing as far as possible the plan of the ground and sites of proposed buildings and roads in their relative positions to any streams or watercourses.

The Provincial Board of Health maintains the right to alter, revise, or add to these regulations from time to time as deemed necessary for the preservation of all domestic water-supply. In cases of emergency the Inspector may make such temporary regulations as are necessary, which shall hold good until passed upon by the Provincial Board of Health.

In cases of dispute between the municipal authorities and the company or individual as to the interpretation of these regulations, the Provincial Board of Health may be appealed to to act as arbitrator. The Provincial Board's decision to be final.

Sanitary Regulations governing Watersheds approved April 2nd, 1918, and July 6th, 1923, are cancelled.

PROVINCIAL BOARD OF HEALTH

Approved by the Lieutenant-Governor in Council, sitting as the Provincial Board of Health, the 13th day of October, 1926.

Dr. Felton, the Medical Health Officer of Victoria, drew my attention to the fact that the word "diphtheria" or "scarlet fever" in sub-section (6) of Section 3 of the Health Act should be left out, as these are not names of water borne diseases.

CONSERVATION

With reference to conserving and thereby increasing the quantity of water that can be obtained from a particular watershed, I have prepared a summary of a number of papers dealing with the effect of forests upon stream flow:

In 1932, Hoyt and Troxell presented a paper before the American Society of Civil Engineers, dealing with the effect of forests on stream flow based on a study of experiments that were carried on for a period of about 16 years in Colorado and California. They obtained the data for their study from a report of C. G. Bates and A. J. Henry, see Monthly Weather Review Supplement 30, Washington, D. C.

In the introduction of their paper they reviewed some of what had been done by others and stated:

"It is strange, but nevertheless true, that until the investigations in the Wagonwheel Gap area were completed, no observations had ever been made of the actual effect of deforestation upon stream flow, conducted on a sufficiently

large scale and covering a long enough time to ensure that the results obtained and the conclusions based upon them would not be subject to serious doubt. The investigations near Wagonwheel Gap and in Southern California differ materially from any made heretofore. The observations were made first on the forested areas for a length of time sufficient to determine their natural characteristics; then one of the areas was deforested and one accidentally burned, and observations were continued after the change. In previous investigations, forested and partly deforested areas have been compared only after the change had taken place and as the regimen of the areas under natural conditions is not known, there is reasonable doubt as to the proper evaluation of the differences in runoff that were observed."

W. G. Hoyt is principal Hydrologic Engineer, Conservation Branch, U. S. Geological Survey, Washington, D. C., and H. C. Troxell is Associate Hydrologic Engineer, Water Resources Branch, U. S. Geological Survey, Los Angeles, California.

Their paper brought forth a number of papers by engineers and by others. I have endeavored to summarize under the title of Forests and Stream Flow, the chief points covered by some of these papers and thought it worth while to state the occupation of the writer of each paper.

FORESTS AND STREAM FLOW

A paper by Col. Chittenden, dated November, 1908, in transactions of the American Society of Civil Engineers of 1909 summarizes the opinions commonly accepted at that time, to the effect that forests exert a beneficial influence on streams flow in the following ways:

1. By storing the waters from rain and melting snow in the bed of of the humus that develops under forest cover, preventing their rapid rush to the streams and releasing them gradually afterward, thus acting as true reservoirs in equalizing the run-off.
2. By retarding the snow melting in the spring and prolonging the run-off from that source.
3. By increasing precipitation; and
4. By preventing erosion of the soil on steep slopes and thereby protecting water courses, canals, reservoirs, and similar works from the accumulation of silt.

Col. Chittenden's study had a negative conclusion. He found no material influence upon stream flow could be attributed to forests.

In 1916 the Special Committee of the American Society of C. E. on Floods and Floods Prevention, stated that if reforestation is con-

sidered merely from a commercial standpoint, the value to the country of producing timber is so great that it obtains general approval. The Committee pointed out that the advocates of reforestation as a means of flood control failed to give any quantitative determination of the effects of forests upon floods.

An extensive investigation by the United States Forest Service and the United States Weather Bureau was conducted from 1910 to 1926 on two contiguous tracts of land in Southern Colorado.

Stream flow measurements by the United States Geological Survey in coöperation with the State of California and the County of Los Angeles were begun in 1916 on certain areas in California.

The data as to the effect of forestation, soil observation and kindred methods of flood control were admittedly not susceptible to quantitative analysis at the time.

The investigation conducted in Southern Colorado was carried out in the Wagonwheel Gap area, for the express purpose of determining the actual effect of forests on stream flow. By chance, also, a forest fire in Southern California destroyed the trees and the undergrowth in an area from which records of stream flow had been collected for 8 years previously. Information, therefore, is available to show quantitatively the effect on stream flow brought about (*a*) by the complete deforestation of a high mountain area having an annually precipitation of about 20 inches (half of which occurs in the form of snow); and (*b*) by the complete denudation of a semi arid costal region on which the annual precipitation ranges from 16 to 60 inches with little snow.

Wagonwheel Gap areas (A, 222.5 acres and B, 200.4 acres) are so small that they were both subject to practically identical meterological conditions. Observations were taken for 8 years before and for 7 years after deforestation, i.e., after the removal of trees from area B. Only in isolated places where slash was burned (comprising small percent of whole) was there actual destruction of soil covering (denudation).

Denudation however correctly describes the change that occurred in the Southern California area.

Mean annual temperature of area A was 34° Fahr. during both periods.

Mean annual temperature of area B was 1.3° warmer after deforestation.

Mean annual precipitation of Area A during first 8 years 21.03 inches, last 7 years 21.16 inches.

Mean annual precipitation of area B during first 8 years 21.10 inches, last 7 years 20.83 inches.

California drainage areas, 6.5 square miles above gauging station on Fish Creek, 10.5 square miles above gauging station on Santa Anita Creek.

Heavy bush growth of sumac and mountain mahogany interspersed with white sage, grass and mucca. Small groups of oak. In the bottom of the canyon along the streams were large numbers of sycamores and alders.

The increase in run-off after the deforestation and fire was not confined to flood periods.

In the Wagonwheel Gap area the maximum increase of run-off occurred during the third year after deforestation. There was a decrease during the flood period in the first and last years, and the principal increases occurred during the second, third and fifth years. In the Southern California area the maximum increase occurred during the second year after the fire. The increase during the flood period occurred mainly in the first three years and was practically negligible in the last three years. The increase during the non-flood period was annually less from the second year to the last.

The run-off during August and September, (the period of low summer run-off), for the third year after the change was increased.

After the removal of the forest cover in area B, the date of occurrence of the summer minimum was delayed about 5 days. After the fire in the Fish Creek area the date of occurrence of the summer minimum was delayed more than a month.

Erosion: Wagonwheel Gap area

In the first 8 years the average annual quantity of silt deposited in the collection basin was for area A, 3.15 pounds per acre, for B, 2.85 pounds per acre. Second 7 years (after deforestation), 2.15 pounds per acre for area A and 16.7 pounds per acre for area B. The higher value represents only a few shovelfuls per acre, and, as Bates and Henry state: "It is only fair to the present discussion to point out that even this large quantity does not represent erosion in the commonly accepted sense of a destructive process."

As to the visible effect, they say: "The erosion from the slopes was practically invisible except for one small gully formed from a skid

trail, and even the erosion from this appeared to be largely deposited upon a leveled road, without reaching the stream."

Erosion: Southern California area

Silt samples were collected in quart jars, the mouth of which was held half way between the bottom and the surface of the stream. Most of the samples were taken where the discharge in the stream was at storm stage.

In the first year after the fire the large deposit of silt from the burned-over area caused considerable damage to orchards, railroads and highways adjacent to the mountains. In the second year the quantity of silt moved was much smaller and caused little damage. By 1930, (5 years) the silt had been reduced to almost normal and the appearance of the stream bed was much the same as before the fire.

The conclusions drawn by Hoyt and Troxell from a consideration of the foregoing researches were set out in a paper read before the American Society of Civil Engineers in July, 1932. They state the conclusions to be drawn from this paper were under seven heads, as follows:

1. Total run-off: Forests did not "conserve the water supply," because after their removal there was an increase in average annual yield amounting to 15 percent in a mountain area in Colorado and 29 percent in a Southern California coastal mountain area.

2. Distribution of increase in run-off. Contrary to the widely quoted opinion the increase in run-off is not confined wholly to flood periods. In both the Wagonwheel Gap area and in the Southern California area, 52 percent of the increase occurred during the non-flood period. The flow during the non-flood periods is derived from the sub-surface storage. The increase during non-flood periods results from either (a) increased subsurface flow and storage; or (b) decreased transpiration; or (c) a combination of both. More of the precipitation may enter storage after removal of vegetative covering for the following reasons: (1) Less interception by trees, undergrowth, tree litter and humus; and (2) faster melting of snow with corresponding decrease in evaporation. The gradual lessening of the increase during the non-flood period in both areas after the second or third year may be a reflection of gradual increase in plant growth and corresponding increase in transpiration.

3. Maximum daily discharge. In the Wagonwheel Gap area there was an average increase of 46 percent in maximum daily discharge after deforestation. This gain is due to increased sub-surface flow, as practically all the snow had melted several days prior to the date of maximum peak. During flood periods following the snow melting the discharge in area B uniformly reached a peak three days or more after that in area A, but after the storm of October 5, 1911,

the peak in both areas occurred at the same time. This was the only so-called flood that resulted from rainfall and indicates that surface run-off from both areas reached the gauging station at practically the same time. In the Southern California area the four storms occurring during the first year after the fire resulted in an increase of 1700 percent in the maximum daily discharge. The peak discharge which was ordinarily 2.5 times the maximum daily discharge prior to the fire, increased to 16.2 times on April 4, 1925, the maximum peak for the period of record. The floods in the Southern California area usually result from rainfall and represent direct surface run-off.

The removal of vegetative covering clearly increases normal flood heights. Beginning in the second year after the fire in Fish Creek the flood peak discharges were practically the same as those which occurred before the fire, indicating that the new growth small as it was, exercised practically the same effect as the original cover in reducing flood crests.

The gradual increase in vegetative covering on the Wagonwheel Gap area B after deforestation had little effect on the increase in flood run-off. This was to be expected in that most of the flood run-off in this area reaches the stream through underground channels.

The earlier melting of the snow in the Wagonwheel Gap area resulted in an advance of three days in the flood peak. Where rain passes directly into streams without entering the ground the flood peak for any small element of drainage area occurs so soon after the storm that removal of vegetative cover has little effect on the time element. In the Southern California area the peak was advanced only a few hours.

4. Summer run-off. It is almost universally believed that forests or vegetative covering will increase summer run-off and shorten the low-water period through the exercise of storage functions. This belief is an outstanding fallacy in so far as these two widely different areas are concerned. The summer flow (July to October) in the Wagonwheel Gap area showed an average annual increase of 12 percent during the seven years after deforestation, and the Southern California area, an average annual increase of 475 percent during the six years after the fire. The absolute average increase of run-off in inches, for both areas was practically the same.

5. Minimum daily discharge and date of occurrence. Coincident with the increase in summer run-off there was an increase in the average summer minimum and the period of low water run-off was considerably shortened. In the Wagonwheel Gap area the average minimum was increased about 12 percent and the time of occurrence delayed about 5 days. In the Southern California area the average minimum was increased more than 400 percent, and the time of occurrence was delayed about 30 days.

6. Winter minimum. Deforestation made no appreciable change in the low flows which occurred during the winter in the Wagonwheel Gap area.

7. Erosion. Erosion results from surface flow. In the Wagonwheel Gap area there was practically no evidence of erosion after deforestation and this was to be expected because there was little direct surface run-off either before or after deforestation. In the Southern California area complete denudation increased erosion as a direct result of the increased surface run-off. So far as the surface features of the Fish Creek Basin were concerned the erosion did not

destroy any present use. However, deposition of eroded material and ash carried by the streams the first year after the fire was materially injurious to agricultural lands and transportation rights of way below the canyon. The growth of new vegetative covering by the second year after the fire was nearly as effective in reducing normal flood run-off as the original cover. It may well be argued, therefore, that if the Fish Creek area had been deforested by cutting of the vegetative cover, as in the Wagonwheel Gap area, without the destruction of the roots and tree litter, the erosion would have been practically the same as with the original vegetative covering.

Mr. C. G. Bates, Senior Silviculturist, U. S. Forest Service, states:

"Foresters, again and again, have pointed out the probability that a watershed, bare of vegetation, is capable of yielding a larger total quantity of water than the same watershed if covered with a forest, and the denser and more luxuriant the vegetation the greater the loss of water to the watershed. This is a biological phenomenon no longer in need of proof.

What foresters have claimed and what universal observation since time immemorial has proved is that a forest cover under certain conditions tends to equalize the run-off throughout the year to increase the storage capacity of the watershed (especially where the soils are thin or heavy and impervious), and to reduce soil erosion. Foresters have further shown that the beneficial effect of the forest cover varies with the climate, the character of precipitation, and, above all, the character of the soil.

Criticism of Messrs. Hoyt & Troxell's paper is not so much against the author's conclusions, as they relate to the specific Western watersheds, but against their attempt to generalize from these watersheds which are extreme in character of soil and climate—as to the protective value of the forest under all conditions.

The authors have omitted many facts that are vital to any logical and sane discussion of the subject of forests and stream flow, of 'watershed protection,' and of the general utilitarian value of forested versus bare lands. While their proposal is carefully guarded and qualified, it tends to leave the impression that sufficient facts have been established to warrant so radical a departure as the elimination of protective forest cover. It is impossible to answer such a proposal in a few words, or even to enumerate more than the most poignant facts."

"The conditions cited by the authors are in no sense 'normal,' although they may possibly be representative of considerable areas in the West.

The authors, while admitting the occurrence of severe erosion within a few months after the Fish Creek fire (which erosion filled the stream channel with débris and did 'considerable damage to orchards, railroads and highways' below the watershed), tend to minimize its importance and state in their 'Conclusions' that 'so far as the surface features of the Fish Creek Basin were concerned the erosion did not destroy any present use.' This bland statement of the harmless effect of one fire begs the question and is misleading. Erosion is a time-consuming process. It normally proceeds almost imperceptibly so far as 'surface features' are concerned, and destructive erosion

gains headway only after the 'harmless' type of erosion has proceeded for a considerable time. Messrs. Hoyt and Troxell have shown that the beneficial effects of the fire denudation began to decrease after a couple of years. It would require repeated fires and almost complete elimination of all vegetative cover to maintain such benefits to stream flow. That destructive erosion would soon follow such treatment is a foregone conclusion, and there is only one logical outcome to the use of the methods proposed by the authors for obtaining greater stream flow—to remove the entire soil mantle of the watersheds and with it every obstacle to quick surface run-off.

It seems scarcely probable that even the people of Southern California would place such stress on increased population and increased water supplies that they would choose to have their entire foothills region assume the barrenness of the upper slopes of Mt. Wilson. Nor is it conceivable that any engineer will argue, in view of the reservoir difficulties which are daily being brought to their attention, that surface run-off carrying a heavy burden of silt is equivalent in practical usefulness to a corresponding volume or clear, sub-surface flow. There may be communities in dire need of additional water, but it is not believed there are any that can afford to obtain it by a method so wholly destructive in its design."

Mr. J. C. Stevens, Consulting Hydraulic Engineer, Portland, Oregon, writes:

"In 1910, the writer was employed on the famous 'Smoke Case' by the Anaconda Copper Mining Company to make a study of the effect of forests on stream flow, climate and soil, with particular reference to conditions in the Deer Lodge National Forest surrounding the huge Washoe Smelter, at Anaconda, Mont. This study was prompted by a suit instituted by the U. S. Forest Service to enjoin the Company from further operation of the smelter on the grounds that the smoke was destroying the surrounding forest and that the destruction of the forests would result in damages amounting to untold millions to the valley of Clark Fork River in increasing its floods, diminishing its minimums and filling its valley with the soil from countless acres of denuded forest areas. The picture set up in the complaint was very gloomy.

The writer entered this study with an open mind, if anything, somewhat biased in favour of the forest-water-supply theory by reason of having absorbed most of the propaganda extant at the time. He gathered all the long-time stream flow records in the world on which decided changes in forest cover have taken place. Among them were the Tennessee, Ohio, Ottawa, Murray (Australia), Merrimac, Sudbury and Croton Rivers. No changes in regimen that by the greatest stretch of the imagination could be attributed to changes in the forest cover, could be detected. Any cyclic variation disclosed in runoff was accounted for readily and simply by similar variations in climatic factors. The generalized results of this study have been published. After this study the writer felt fully convinced that the forest-water-supply theory belongs in the catalog of political expediencies rather than that of the sciences. The governing factors belong to forces far beyond his power to control.

Recently, the writer had occasion to go over a part of the lands around the

Washoe Smelter, that were the subject of such intense study twenty-two years ago. The smoke has killed practically all the trees leeward of the smelter for many miles. Of course, Government and private owners have been amply compensated for their loss. The streams flowing from this graveyard of trees still run crystal clear and sparkling. There is no diminution in the supply as far as ocular evidence can be trusted. There is no more evidence of soil erosion than existed while the trees were alive and green.

Every one loves the forests; every one is glad they are in the hands of the Government and is grateful that they are being conserved for this and future generations. Their value for timber supplies, for recreational playgrounds, and to soothe aesthetic senses are ample and cogent reasons for preserving that control. If it was necessary once to atrribute to them properties they do not possess, in order to "kid" the people and Congress into doing the thing that everybody wanted done anyway, that necessity has passed. Forest control is now a blessed fact. Is there any further necessity to keep up the farce?"

Mr. Harry F. Blaney, Irrigation Engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Los Angeles, writes:

"Some investigators have been forced to the conclusion that in respect to run-off, each stream is a law onto itself."

Run-off, according to Meyer, constitutes the residual precipitation after evaporation, transpiration, and deep seepage losses have been supplied, and the demands of evaporation and transpiration require from 15 to 28 inches of precipitation per annum. Zon states that the water consumed by the forest is nearly equal to the total annual precipitation.

Little information is available as to the quantity of water lost in the bottom of canyons through evaporation and by transpiration from vegetation. In the spring of 1929 some experiments were conducted by the U. S. Bureau of Agricultural Engineering on the "consumptive use" of water by native vegetation along stream channels in Temescal Canyon 4 miles southwest of Corona, Calif. The vegetation consisted of willows, tules and kindred moist land growths. For a 30-day period, from April 28 to May 27, inclusive, the total transpiration was 12.9 acre-inches per acre.

Dr. Daniel W. Mead, Professor of Hydraulic and Sanitary Engineering, University of Wisconsin, referring to the paper of Hoyt & Troxell, writes:

This excellent paper presents the most exact and conclusive measurements that are available of the effect of deforestation and denudation of drainage areas on the flow of streams. The only uncertainties in the conclusions as regards the streams discussed seem to be in the relative quantity and distribution of the rainfall on the areas of the Santa Anita and Fish Creeks in Southern California, and the possible different effects of such variation of rainfall on the comparative flow of these streams before and after the time when deforestation and denudation occurred. It will be noted that the only rainfall stations available for these areas are at Mount Wilson and at the

Santa Anita Ranger Station both of which are west of Fish Creek and cannot represent the rainfall accurately on that drainage area which, in each rainstorm, would probably vary somewhat from the rainfall at these stations just as the rainfalls at the stations vary one from the other. The increase in flow from the drainage area of Fish Creek, however, is so considerable that there can be no question as to the actual increase in flow resulting from the deforestation and denudation of the fish creek drainage area, although the actual quantity seems somewhat uncertain.

The rainfall measurements on the Wagonwheel Gap area are much more complete and represent the actual conditions as well as they could reasonably be determined. In the writer's opinion there can be no doubt as to the essential validity of the general conclusions that will be drawn from these data, that, in general, increased flow will follow deforestation and denudation on small drainage areas where other factors remain the same.

It is obvious that: (1) The relative results of deforestation or reforestation in each case must depend upon the physical and climatic factors that prevail on the areas from which such results obtain; (2) in applying these data to other small areas, the comparative physical and climatic factors of such areas must be considered; and (3) any variation in such factors will necessarily modify the results to be expected.

In extreme and rare cases it is possible that deforestation and especially denudation, of small drainage areas might even reverse the results obtained under the conditions considered by the authors.

Mead states that, according to Harrington, on an average only 70 percent of the rainfall reaches the ground under forest covering, and that 30 percent is re-evaporated from the trees and their foliage. He gives a table showing that the daily consumption of water by most crops is several times greater than of oak and fir trees.

Mead also says that Edward Burr investigated the result of reforestation in the Merrimac River Basin. He states (1919) that (1) deforestation continued progressively from the earliest settlement to about 1860–70; (2) reforestation through natural processes progressed from 1870 to 1910 at a rate that has increased from 1880 to 1900, or later; and (3) forest areas were larger in 1910 than 1860–1870 by as much as 25 to 30 percent of the entire basin. Perhaps better data (longer and more accurate) existed for this area as regards rainfall and stream flow than on any other for which similar studies have been made. He found no evidence that deforestation had modified the stream flow of the Merrimac River in any way. In this connection it seems pertinent to call attention to the fact that the highest floods that have ever been recorded on the Mississippi at St. Louis, Mo. were in 1785 and 1844, long before deforestation could have had any effect on the flow of that river.

Mead in summing up the work of Burr, Chittenden and others concludes that (*a*) on large drainage areas any acts of men except the construction of relatively large storage reservoirs or extensive flood protection works, are so limited in extent that they can have little influence on the flow of streams, (*b*) stream flow follows rainfall; and (*c*) large floods are due to torrential rains, together with other physical

and climative conditions favorable to flood conditions. On small areas the cultivation of the land and the existence of extensive forests may have a considerable effect in decreasing the flow of small streams draining such areas, except that such effects are so small that they are likely to become insignificant and indetermiate on the flow of the main streams to which these small streams are tributary.

Mr. George H. Cecil, Executive Secretary, Conservation Association of Los Angeles, Calif. writes:

The quantity of eroded material carried by the floods from Fish Canyon is given little weight by the authors in arriving at their conclusions. The truth is that the detrital matter carried by Fish Creek, Sawpit Canyon and Rogers Canyon, as an aftermath of the 1924 fire, not only damaged and destroyed a considerable area of agricultural land, but cost thousands of dollars for removal from highways and the railroad along the base of the mountains.

In fact, the deductions made by Hoyt and Troxell on the Wagonwheel Gap and Southern California areas, if carried to their logical conclusion, would defeat the objectives sought in increased summer flow. With the destruction of the watershed cover, the loose material would be carried eventually by the torrential rains down the steep canyons on to the valleys below. Even if the resulting damage could be ignored, as is suggested, the materials in which must be stored the water to produce the increased summer flow indicated, would themselves be carried away eventually. The result would be that the entire winter precipitation would immediately find its way to the valleys, and the summer flow would be nil.

(Presented before the Pacific Northwest Section meeting, May 15, 1936.)

RECENT ADVANCES IN THE CONTROL OF CHLORINATION

By Charles R. Cox

(*Associate Sanitary Engineer, State Department of Health, Albany, N.Y.*)

The well known orthotolidine test for residual chlorine is easily made with simple equipment, and thus the tendency is to consider the test as satisfactory and one needing little attention in seeing that reliable results are secured. In reality, however, this apparently simple test is influenced by many factors which must be borne in mind to insure reliable results under varied conditions. Because of this situation a great deal of thought has been given to developments of reliable procedures for correcting errors, and in the development of a more satisfactory test for residual chlorine. These studies have resulted in complete revision of the Standard Methods of Water Analysis, and the 1936 edition now in press will contain new procedures for correcting for errors due to nitrites and manganese present in some waters.

It is desirable that these weaknesses of the orthotolidine test and factors affecting the results be discussed briefly.

DISINFECTION PERIOD

The period between the time when chlorine is applied to the supply and the orthotolidine solution is added to a sample of chlorinated water represents that portion of the disinfection period during which the concentration of residual chlorine is gradually decreasing from the amount present immediately after the chlorine is applied to that present when the orthotolidine solution is added to the sample. Experience has shown that this period should be 10 minutes in order that the results will indicate the presence of a definite concentration of active chlorine for at least that period. The practice of adding the reagent immediately after collecting the sample, therefore, is incorrect, as it merely shows the residual after the immediate chlorine demands of the water has been satisfied, and not after a definite disinfection period.

Prechlorination before filtration is controlled by making the orthotolidine test of samples of the freshly chlorinated water and also of the settled water. Naturally the latter samples need not be held in the bottle for ten minutes before adding the reagent, because the residual present in the water *as sampled* is the desired result. The same would apply to the testing of water treated with chlorine and ammonia, where the residual present throughout the distribution system, or after the treated water has passed through an open, equalizing reservoir, is being determined as a guide to algae control in the reservoir.

REACTION PERIOD BETWEEN ORTHOTOLIDINE REAGENT AND RESIDUAL CHLORINE IN THE SAMPLE

The characteristic color resulting from this reaction develops in 3 to 5 minutes with conventional chlorination and with warm water temperatures. Furthermore errors due to nitrites, iron and manganese, discussed below, are minimized by observing the color in 3 minutes, and not the stronger colors produced with longer reaction periods. The 3 to 5 minute period is satisfactory, when the chlorine-ammonia treatment is being controlled, provided the pH is below about 8.0 and the ammonia-chlorine ratio is 1 to 3. Reaction periods of 10 to 15 minutes should be used with pH values over 8.0 and ammonia doses exceeding one-third the chlorine dose.

TEMPERATURE OF THE WATER

The reaction with orthotolidine reagent, leading to the production of the color, proceeds very slowly in cold water, and thus samples of cold water should be warmed to 15 to 20 degrees centigrade, or 60 to 68 degrees Fahrenheit to insure reliable results. This may be conveniently done by placing the sample in an Erlenmeyer flask which is then partly submerged in boiling water and agitated in the meantime by shaking the flask. In this way excessive heating of the sample is avoided. Moderately cold water may be warmed by holding the small bottles or tubes in the hand or in contact with radiators.

pH AND ALKALINITY

Waters of high alkalinity, such as those softened by the lime-soda process, require the use of a more acid orthotolidine solution than that prepared in accordance with previous editions of Standard Methods of Water Analysis. The 1936 revised procedure will be discussed below.

The errors due to alkalinity may be avoided to a considerable extent by adding 2 or 3 cc. of the standard orthotolidine reagent to 100 cc. of the sample, rather than 1 cc. specified for the usual test.

EXPOSURE TO LIGHT

Orthotolidine reagent and standard color solutions deteriorate rapidly when exposed to light. Furthermore strong light materially influences the reaction between chlorine and orthotolidine and hence the test should not be made in direct sunlight. The reagents and color solutions stored in the dark will give reliable results for a period of six months, following which they should be replaced by fresh solutions. The reagent should be placed in brown glass bottles as additional protection from the light.

SOURCE OF LIGHT

The intensity of color produced by the orthotolidine reagent should be observed by allowing diffused daylight to pass through the tubes or bottles containing the sample and reagent. The average electric light bulb, however, produces an orange light which will not give satisfactory results when the test is made at night. So-called daylight lamps are available and should be used when the test is made at night.

TURBIDITY AND COLOR OF WATER TESTED

The natural turbidity and color of some chlorinated waters interfere with the accuracy of the orthotolidine test unless compensated for. Commercial equipment for making the orthotolidine test is designed to compensate for such errors. It is possible to use two ounce, French square bottles and compensate for these errors in the same way by placing a sample of water *not* containing orthotolidine reagent behind the bottle containing the standard color solution, and by placing a bottle of distilled water behind the sample containing the orthotolidine solution, whereby the light reaching the eye through the standard and sample will pass through and will be modified to the same degree by the color and turbidity, glass walls of the bottles, and the same depth of water.

Errors due to the presence of nitrites, manganese and iron in chlorinated water being tested, as discussed below, are due to the fact that the orthotolidine reagent is an indicator of oxidizing agents including chlorine, and not specifically for chlorine alone. It follows, therefore, that compounds capable of liberating oxygen will give false

colors with orthotolidine. Nitrites, manganic and ferric compounds are such compounds.

ERRORS DUE TO THE NITRITE CONTENT OF WATER

The nitrite content of most chlorinated waters is not sufficiently high to lead to difficulties with the orthotolidine test. Furthermore nitrites in the raw water will be oxidized by free chlorine to nitrates, the latter having no effect on the test. With the chlorine-ammonia treatment, however, an excess of ammonia ordinarily is applied, and this excess may be oxidized, with water temperatures greater than 50° Fahrenheit, to nitrites by nitrifying bacteria in filter beds or reservoirs, which apparently are not killed by moderate concentrations of chloramines. Errors due to nitrites, therefore, should be anticipated when testing the effluent of filter plants where pretreatment with chlorine and ammonia is practiced and where the concentration of residual chlorine remaining in the filtered water is being determined. Incidentally, nitrites are likely to be present in the water in swimming pools, even when the ammonia treatment is not used.

Concentrations of nitrites greater than 0.03 p.p.m. are likely to cause serious errors with this test. One should be cautioned not to use the hydrogen peroxide modification of the orthotolidine test, previously suggested to avoid errors due to nitrites, because this modification has been found to be unreliable. Unfortunately we know of no modification of the orthotolidine test which will compensate for errors due to nitrites. The neutral, starch-iodide test, described below, should be used when nitrites give difficulty.

IRON CONTENT OF WATER

Ordinary concentrations of iron in water do not produce errors with this test. Oxidized or ferric iron present in concentrations greater than 1.0 p.p.m. will produce errors. The 1936 edition of Standard Methods will recommend that such errors be compensated for by a special procedure designed to precipitate the iron. Unfortunately, however, this procedure is complicated and can be followed only in the laboratory, as discussed below. The neutral, starch-iodide test, however, may be used.

MANGANESE CONTENT OF WATER

Water from impounding reservoirs covered with ice in the winter, or in the late summer months when stagnation in the lower portion

of the reservoir leads to the solution of iron and manganese from the flooded soil, may contain sufficient manganese to seriously interfere with the accuracy of the orthotolidine test. The oxidized manganese or manganic compound when present in concentrations exceeding 0.01 p.p.m. will produce such errors and thus the new edition of Standard Methods will recommend the use of the special procedure mentioned above in connection with the discussion of errors due to iron.

There are two appropriate, simple procedures, however, which can be followed to enable errors from manganese and iron being ascertained in the routine testing of water in the absence of elaborate laboratory equipment.

First. The sample of chlorinated water is boiled to expel the residual chlorine. The water is then cooled and restored to its original volume by the addition of distilled water following which the orthotolidine test is made as usual. The apparent chlorine content of this sample represents the value in terms of chlorine of the error due to iron and manganese. The apparent chlorine content of another sample of chlorinated water tested as usual after a 10 minute period, represents the value due to chlorine plus that due to iron and manganese. The difference between the two results, therefore, represents the net or true chlorine content. Unfortunately, however, boiling the sample may lead to either the reduction or oxidization of some of the manganese and iron, which in turn would decrease or increase the error, depending upon the pH value of the water. In general, however, this simple procedure produces approximate results.

The second simple procedure would be the collection of two samples of chlorinated water. Orthotolidine reagent would be added to one sample after the customary ten minutes reaction period, while the second sample would be allowed to stand for 24 hours, during which period the residual chlorine would disappear by reacting with organic matter in the water. The orthotolidine reagent then should be added to this second sample. The apparent chlorine content of the second sample would represent the error due to iron and manganese compounds, or other interfering substances. This value should be subtracted from the apparent chlorine content of the sample examined at once to secure the net chlorine content. This procedure obviously is based upon the assumption that the oxidation of the manganese and iron compounds by the chlorine is completed during the ten minute reaction period, and also that residual chlorine will disappear

from the second sample in the 24 hour period. This, of course, will not be the case with water treated with chlorine and ammonia, so the boiling method discussed above must be used with this treatment.

MODIFIED ORTHOTOLIDINE TEST ACCORDING TO THE 1936 EDITION OF "STANDARD METHODS OF WATER ANALYSIS"

The 1936 edition of Standard Methods will contain a modified orthotolidine test, whereby errors due to iron and manganese are eliminated by precipitating these minerals with magnesium sulphate and sodium hydroxide, following which the sample is centrifuged. The clear supernatant water freed of iron and manganese in this way, is decanted into a 100 cc. Nessler tube, and special orthotolidine reagent is added. The color is compared with standards after 5 minutes.

The special orthotolidine reagent is much more acid than standard reagent, as it consists of 100 cc. of the standard reagent to which 100 cc. of distilled water and 60 cc. of concentrated hydrochloric acid have been added.

It is evident that this procedure cannot be followed in the field or without special laboratory equipment not always available.

THE QUALITATIVE STARCH-IODIDE TEST FOR RESIDUAL CHLORINE

Directions for making the starch-iodide test usually involve the addition of acetic acid to the water before the starch-iodide reagents are added. Manganic and ferric compounds, however, will interfere with the *acid* starch-iodide test. This interference, however, does not occur with pH values in excess of about 6.0. It is possible, therefore, to use the *neutral* starch-iodide test in avoiding such errors. This consists in adding several crystals of potassium iodide, then 10 to 20 drops of the starch solution. The production of a blue color in 5 minutes indicates the presence of residual chlorine.

Unfortunately, however, permanent color standards can not be prepared for use with this test. A definite blue color, however, indicates the presence of residual chlorine in concentrations exceeding about 0.10 to 0.15 p.p.m., and thus the production of a definite blue color may be used as a guide in chlorine treatment.

STANDARD, QUANTITATIVE STARCH-IODIDE TEST

The 1936 revision of "Standard Methods" will include a quantitative, neutral starch-iodide test for use when the nitrite content

exceeds 0.03 p.p.m., or as an alternate to the modification of the O-T test, described above for use when manganese and iron is present in the water. The principle of the test is the same as the simplified starch-iodide test described above, except the quantity of residual chlorine present is accurately determined by titration with sodium thiosulphate. This latter solution must be prepared frequently and accurately standardized. Furthermore the test is delicate and requires the use of considerable laboratory equipment. This test, therefore, cannot be made in the field, or by those lacking chemical experience.

In summary, the accurate control of the chlorination of water requires care in testing for residual chlorine, using precautions to see that errors outlined above are not encountered. In general, the present methods of determining the concentration of residual chlorine are not satisfactory when interfering substances are present. Hence it is very desirable that water works chemists devote their efforts to the development of a new test utilizing some indicating substance other than orthotolidine or potassium iodide.

(*Presented before the New York Section meeting, March 26, 1936.*)

ECONOMIES EFFECTED BY CONSTRUCTIVE PLANNING

By Edgar K. Wilson

(Chief Engineer, The Pitometer Company, Engineers, New York, N. Y.)

This paper will deal with some of the economies to be obtained in water works operation and construction by proper planning. It considers only plants which are already operating, and since every plant is a problem by itself no specific statements of actual savings will be made.

A typical plant will be considered as follows:

Source of supply and supply works
Pumps at source
Supply main of some considerable length
Purification works
Main pumping plant
Trunk mains to distribution system
Secondary feeders and distribution system
Services and meters

SUPPLY

Taking these in order, our first point is the source of supply and supply works. Given an adequate and satisfactory source this is a matter of little concern; but in cases where the supply is inadequate or where droughts may cause trouble it becomes of the greatest importance to have complete plans in readiness to insure a continuance of supply. In such cases there are only two remedies. The first is to increase the supply by tapping another source, involving heavy expenditures for dams, supply lines, and possible additional pumping equipment. The second is by reducing the consumption to a point where the present supply will be adequate. This may be done by restricting the domestic use by prohibiting lawn sprinkling or even by cutting off water entirely except during certain hours as has sometimes been necessary. These methods are always unpopular and often hazardous. Other methods are the location and repair of underground leaks by means of a water waste survey and by complete metering of all services to eliminate house waste. These

methods may and often are sufficient to postpone increase in supply works for a number of years—a real saving in interest cost. Every plan for increased supply should include in its consideration both of these measures.

PUMPS

Any reduction in the amount pumped to the city will reduce the cost of operation of the pumps. If pumping is at a certain rate to the purification works, it will be possible to run the pumps for a shorter period, cutting down the bill for current if electrically operated, or even perhaps allowing operation during the off peak period at the minimum charges. A reduction will also cut down the head pumped against, since we are assuming a supply main of considerable length, and friction losses decrease rapidly when the velocity is reduced.

SUPPLY MAIN

If the supply main is operating at nearly its capacity a careful investigation should be made to determine its carrying characteristics. It may be that its walls are corroded or that it is partially filled with silt so that its friction is restricting its flow. As stated above the friction losses will be reduced by a reduction of consumption, and such losses can be still further cut by cleaning the main by modern methods. It is quite possible that either or both of these methods will so increase the surplus capacity of the main as to postpone a duplication for several years. Since the cost of construction of long stretches of large main is very expensive, again there would be a considerable saving of interest charges over a term of years.

If the distribution is directly supplied through such a long main and its interior condition is bad, it would be very easy to lose 10 or 15 pounds pressure or even more in pumping to the city. In case of a fire at a high point in the system, this loss might cause serious deficiency in the supply.

A careful study of the matter such as given in the course of a complete distribution study might reveal that economies would be effected by paralleling the main, which with a new main the same size as the old would cut the friction loss by about 75 percent; or by construction of a tank or reservoir at the city end of the line, allowing steady pumping at the most efficient rate or, as mentioned above, permitting pumping during off peak hours to receive the minimum rate.

PURIFICATION WORKS

The cost of operation of the purification works depends on their design and the amount of water which must be supplied. Assuming that the design is proper for the conditions, the cost of operation is reduced by lower cost of chemicals and the cost of production of water used in washing filters if the underground leaks and house waste are eliminated.

MAIN PUMPING PLANT

The next item has to do with the pumping equipment at the city end. At this point there is found much more frequently than is realized a considerable waste which can often—or usually—be eliminated by planning and reconstruction after careful investigation.

Often pumps are installed which are of too great capacity for the low flows. In a direct pumping system with small reservoir or tank capacity, this may result not only in a waste of power but in actual loss of water; since the tank cannot hold up long enough for the pump to shut down for any considerable period, and the water must be wasted through the overflow of the tank.

Again pumps designed to pump against given heads are used under quite different conditions with corresponding loss of efficiency.

A careful study of efficiency tests as well as the conditions under which the pumps are operating may show that it will be real economy to junk all or part of the present equipment and replace with new pumps designed for the conditions under which the plant is operating, with units which singly or in combination will take care of the varying requirements of the community.

TRUNK MAINS

The force mains to and the subfeeders of the distribution system are usually not of extreme length, but they merit careful testing and consideration for carrying capacity, since if they are obstructed or corroded the pumps must work against a higher pressure to force the water to the point of demand. We sometimes hear a man say, "Why, this main has a coefficient of 80, which is what the Williams-Hazen Tables call for in a main of this age." He does not realize that in spite of the close agreement the carrying capacity can be considerably increased and his pumping head decreased through cleaning the main by modern methods.

Planning for present requirements and future needs should include

a complete trunk main survey which will give definite information on the amount of flow through the trunk main, its direction—not always as might be expected—and an analysis of its distribution into the system, as well as the flow characteristics of the main itself. From such a survey it can be seen what mains are overloaded or are not carrying their share of the load; and designs can be made to bring the latter into proper step with the system. This, often at very slight construction cost, will result in economies of pumping, and in some cases will postpone or perhaps eliminate entirely the need of expensive construction of new mains. Reduction of flow by suggested methods will provide additional reserve capacity at no expense for construction of new pipes.

It is in such mains and in the distribution system that the greatest economies in planned construction are possible. It is safe to say that a majority of our water works systems have simply grown up without any planning for the future. In many instances the water department has been a neglected stepchild of succeeding administrations, given barely enough money to carry on the most necessary maintenance work. If the water rates seemed about to yield a little surplus which might be used for improvements, the rates have been lowered or the surplus has been switched into general funds, or used for relief or for some other equally worthy object—all in the name of saving the poor tax payers' money. As a consequence the service is mediocre. The Underwriters make a report which shows serious deficiencies in fire protection in important sections, inefficient operating conditions at the pumping station, poorly maintained pressures, with gates and hydrants in neglected condition, while their recommendations bristle with the stars meaning "must or else!" It is to be hoped that the day of reckoning for such a plant will not come in the form of a conflagration which in its earlier stages could have been controlled with adequate pressures and supply.

SECONDARY FEEDERS AND DISTRIBUTORS

"City Planning" is not particularly new and it has always been necessary to make fairly complete plans for future sewers, at least for the main trunks leading to the outlet. It is just as important that we should know what size pipes and where they are to run for the water system. Every community should have a carefully prepared plan of procedure of construction for its distribution system and trunk mains, based on probable growth, water consumption both as a

whole and in various sections, amount of water available for fire protection at points throughout the system, and a complete pressure survey. From such data the approximate date can be predicted at which the more important betterments will be needed, thus on the one hand avoiding unnecessary interest charges, or on the other the embarrassment from a lack of the improvement after its need has become apparent. Aside from this possible saving of interest charges there may be an additional economy due to the ability to purchase material at a favorable market in advance of the actual time of construction.

Perhaps the greatest saving due to planning for the future, especially for the pipes in the more thickly settled areas, will be found in the saving in paving repairs. By having a complete plan for future operations new mains or the replacement of old mains can be constructed in advance of paving and repaving. In these days of heavy concrete base pavements and reinforced concrete roads this is a matter of great importance. While it may be possible to open such a street for actual repair work, restrictions covering a term of years are often imposed against new construction; and even if such construction is allowed, the pavement repair bill will run very high.

It is in such cases as these that the value of a planned construction program is most evident. Where an expensive pavement is to be laid the water works official may consult his program, and if a main of the proper capacity is already in place he may rest easy in the knowledge that no replacement will be needed in that street after the pavement is down. On the other hand, he is in position to make the needed replacement if it is indicated.

SERVICES AND METERS

Perhaps the items of services and meters are not exactly pertinent to the subject of this paper but economies may also be effected in these. Most water works systems have long adopted the type of service which seems best adapted to the local water, and any innovation in the material must prove its worth before adoption. This paper has nothing to do with this phase of the matter; but it is suggested that where service pipes are maintained by the property owner from the main to the meter or into the house, the water department has little control over this part of the supply system. It is often difficult to get leaks repaired promptly when the owner has to make the repairs. The cost of supplying water to such leaks keeps right on until the leak is stopped.

A meter inspection program will often yield economies, if properly carried out. The only way to know how much water supplied at the source is actually paid for is by meters on every service including schools and other public buildings and the only way to keep these meters within a small percentage of the truth is by periodic testing, the term between tests being dependent on the action of the water on the meters.

SUMMARY

The economies may be summarized, then, as follows:

In the source and supply works, supply main, purification works, pumping equipment and trunk mains, economies will be effected by reducing the flow by elimination of underground leaks and house waste by water waste surveys, and by trunk main surveys with necessary addition of new mains or connections based thereon, to reduce friction losses and pumping heads.

In the pumping equipment economies will be effected by using pumps suited to the needs, and of such capacities that flexibility of operation will be possible.

In the trunk main and distribution system economies will be effected by a complete distribution study from which a master plan is made. This plan if followed will reduce interest charges due to construction at too early a date and especially will avoid cost of pavement repairs where mains may be laid or replaced in advance of expensive pavements. Incidentally such a plan will assist in keeping trained foremen and men employed and available for emergencies.

For services and meters economies may be effected by properly planned inspections and tests.

It will be seen that the bases of all comprehensive planning are: (1) the elimination of underground leakage and house waste by a water waste survey, universal metering, and/or intensive house to house inspection, with tests of pumps for efficiency and adaptability; (2) a trunk main survey to determine the carrying characteristics of the trunk mains and an analysis of their flows; (3) a complete distribution study to determine what mains should be replaced or constructed to provide large centers of consumption with adequate supplies of water and to give proper fire protection throughout the community.

(Presented before the New York Section meeting, March 27, 1936.)

IS YOUR WATER SUPPLY ADEQUATE FOR FIRE PROTECTION PURPOSES?

By J. B. Wilkinson

(*Chief Engineer, Wisconsin Fire Rating Insurance Bureau, Madison, Wis.*)

No discussion of water supply for fire protection would be worth while if confined solely to consideration of adequacy of the service, without taking the reliability into account. The point of view from which I shall discuss the subject is naturally that of the fire underwriters, as exemplified by the Standard Schedule for Grading Cities and Towns with Reference to Their Fire Defenses and Physical Conditions, which is sponsored by the National Board of Fire Underwriters. This schedule, as most of you are probably aware, is included as a supplement in Water Works Practice, the manual issued by your parent body.

QUANTITY

The quantity considered necessary for adequate fire protection is that required for a very severe block fire, or for two simultaneous fires of considerable magnitude. It is not considered necessary to supply all the water which may be used and wasted in a large conflagration involving an entire business district, as observations of the performance of water supply systems in several large conflagrations has shown that very large quantities may be wasted through broken services and abandoned hose lines, and it is not considered reasonable to require a system to supply unlimited waste. However, in estimating the fire flow requirements, the fact that some water is likely to be wasted is considered. The approximate ratio of the fire flow required to engine capacity—that is, to the quantity which it is anticipated will actually be delivered on the fire—is as three is to two.

Fundamentally, the quantity of water estimated as necessary for adequate protection is based on the structural conditions in a city. Since it is ordinarily found that structural conditions are approximately similar in cities of like size, it has been found convenient to

determine the fire flow from an empirical formula, in which the quantity is a direct function of the population. This formula was developed by engineers of the National Board of Fire Underwriters after careful review of all the data available when the standard schedule was first formulated, and after consultation with eminent water works and fire department authorities. Approximate values of the fire flows produced by the formula for cities of various population are given in a table on page 14 of the Standard Schedule.

The fire flows judged necessary vary from 1000 g.p.m. for a village of 1000 population, 3000 to 6000 g.p.m. for cities of 10,000 to 40,000 population, up to 12,000 g.p.m. in a city of 200,000 population, with 2000 to 8000 g.p.m. additional required in cities over 200,000 as an allowance for second fire. In general, these are the quantities considered necessary to cope with a block fire in the congested value district. For other districts the quantities needed for adequate protection are judged to vary from 500 g.p.m. in a sparsely built residential district, with about one-third of the lots in a block built up, in which buildings are low and of small area. With somewhat increased congestion and larger or higher residential buildings, 1000 g.p.m. is considered adequate. Where congestion becomes considerable, or where buildings approach the dimension of high value mansions or hotels, 1500 to 3000 g.p.m. is considered necessary, and up to 6000 g.p.m. may be required in densely built sections of three story buildings.

Since the domestic consumption of water does not stop during a fire—you all probably remember the radio appeals to conserve water, broadcast during the 1934 Chicago stock yards fire—a water works system which is truly adequate must supply domestic consumption in addition to the fire flow which is needed. The relative demand on the plant to supply domestic and fire service varies greatly between small and large cities. In a small place the fire flow demands are disproportionately large as compared with even the maximum day's consumption, and as a result the supply for fire protection is almost always inadequate in such towns. In contrast, the required fire draught in a very large city, expressed as a percentage of maximum consumption demand, is relatively minor, and the supplies in such cities, unless they are located in a territory where water is difficult to obtain, are usually adequate. Taking the Manual's estimate that 100 gallons per capita per day is representative of the average domestic demand, and that the maximum daily demand is approxi-

mately 50 percent in excess of the average, the fire and domestic requirements become equal in a city of about 75,000 population.

STORAGE

A supply from a source of limited capacity, as from wells, can be made adequate by the provision of storage which can be delivered at a high rate for a limited period. In considering storage as supply-fire flow, it becomes necessary when comparisons are to be made that some definite time as to the duration of the fire demand be assumed. For cities of under 2500 population this period is more or less arbitrarily assumed as 5 hours; for larger cities it is assumed as 10 hours.

Storage, whether it be in ground reservoirs or in elevated reservoirs or tanks, is almost always subject to some fluctuation and that portion of a reservoir which is not filled is, of course, useless. The extent of fluctuation in storage varies widely in different places, and much depends upon the method of operating the plant. A certain Wisconsin city of about 20,000 population, has a one-half million gallon gravity tank. Records indicate that the normal daily minimum is only about 20 percent of its gross capacity, and the absolute minimum which has occurred during periods of maximum domestic demand, is 12,000 gallons. This tank, if kept full, could maintain a flow at a 1.2 m.g.d. rate for 10 hours, or about 20 percent of the required flow for this city, but with the present scheme of operation while it is useful as an equalizer, it is of little value as a source of supply.

PRESSURE

Let us now consider the adequacy of a system from the standpoint of the pressure which is carried. The prevailing pressure will determine whether water can be used to supply streams direct from hydrants, or whether fire department engines are necessary as boosters. Sixty pounds is about the minimum pressure at which direct hydrant stream can be considered satisfactory in a place where construction is at all congested, or where three stories is the prevailing height of buildings, and this 60 pounds pressure will be satisfactory only where hydrants are closely spaced and short hose layouts can be used. Ordinarily, 75 pounds pressure will be necessary to serve the congested value districts of cities of any size by direct hydrant streams, and then some engine capacity will usually be needed to provide service in the higher portions of a few tall buildings. As a

supply for fire department engines, 20 pounds is considered the minimum desirable residual pressure, this being about the lowest at which reasonably satisfactory domestic service can be maintained in districts near, but not involved in the fire. Relatively few of our cities have pressures sufficiently high and distribution systems sufficiently strong to render adequate service without the use of fire department pumpers.

DISTRIBUTION SYSTEM ADEQUACY

The development of an adequate water supply avails little unless it is coupled with a distribution system capable of delivering the necessary quantities of water to the areas in which it will be used. An adequate distribution system presupposes arterial feeders which are capable of delivering the required fire flow plus maximum domestic consumption in accordance with the needs of various sections of the city. Where topography and other considerations will permit, it is very desirable that arterial feeders be looped. Minor distributors should in no case be smaller than 6 inches, even insparsely built outlying districts, and such distributors should be increased in size as the height, area, and congestion of buildings becomes greater. In high value districts of cities of perhaps 5000 population and over, 8 inches is the minimum size of pipe which should be used. It is needless to say that frequent cross connections, preferably at intervals not exceeding 600 feet, are very desirable. These comments on distribution systems are very general, as you will recognize the impossibility of outlining in a few sentences specifications sufficiently broad to fit all cities in which the required fire flows may range from 2000 to 20,000 g.p.m.

Hydrants in all except the smallest villages, should have at least a 6-inch hub, and branch and a 5-inch foot valve. At least one 4½-inch steamer outlet in addition to the usual 2½-inch hose outlets is desirable even in small places, especially where there is some probability of future growth.

Up to this point I have spoken of adequacy from the standpoint of quantity or pressure. In the broader sense, an adequate system should also be reliable to the extent that with such parts as may reasonably be expected to be inoperative at one time or another out of service, plant will continue to supply consumption and fire flow, and be able to maintain normal pressures.

RELIABILITY

The simplest system is inherently the most reliable, and in those systems with limited reserve units the unreliability will ordinarily increase proportionately with the number of operations necessary to deliver water from the source of supply to the distribution system. On the other hand, with ample reserve equipment, there seems no reason why a complicated system with low lift pumps, filters, and high lift pumps, can not be made essentially as reliable as a simple gravity system.

The criterion of reliability of pumping equipment and of power prime movers is the ability to supply maximum domestic consumption and deliver required fire flow with two largest units out of service. It is a recognized fact that any piece of mechanical equipment must be taken down at intervals for inspection and repair, and it occasionally happens that a second unit will go out of service at such a time for some unanticipated reason. Sufficient reserve boiler capacity should be provided for steam operated equipment to maintain full service with one-fourth of the boiler capacity, or in any event the largest boiler, out of service for cleaning or repairs. Piping and valves in the plant, both for steam and water—and also air, if air lift pumps are employed—for the most reliable service should be so duplicated that no single break, or the repair of any single valve, will interfere more than momentarily with the delivery of the necessary quantities. While in a small plant this degree of reliability is usually unattainable, by keeping the goal in mind, much can be done to at least minimize the effect of an accident.

Electric transmission lines should be in duplicate, with quick change-over facilities from one to the other. If many machinery units are supplies, the maximum reliability will be obtained from a sectionalized electrical bus. Electric power distribution by underground transmission lines is greatly superior to overhead distribution as the probability of damage by lightning, windstorm, sleet, or by a fire along the route traversed by the overhead line, is eliminated.

The same considerations as have entered into the design of station piping apply with equal force to the mains of the distribution system. Looping of feeders, a good gridiron, moderate spacing and favorable arrangement of valves, will do much to minimize the effect of a break. Hydrants supplied direct from arterial mains should invariably be individually equipped with gate valves in the hydrant

branch; whether or not hydrants fed from other mains need be gated will depend upon the interval between sectionalizing valves in the distribution system.

Storage tends to reduce the unreliability of equipment through which the water has passed. Thus ground storage may offset in whole or in part the lack of adequate low lift pump reserve, and elevated storage the lack of both low and high lift pump reserve.

Considerable time is required to make major repairs to equipment, especially when the units are of large capacity. It has been thought reasonably to assume that five days will suffice to make most of the repairs in a water works system. The demand for water for domestic use may be expected to continue as usual, even though certain vital parts of the plant are out of service. If the equipment which remains is of sufficient capacity to supply domestic consumption and permit storage to be maintained at its normal value, the effect on the fire flow will be minimized. If, however, the capacity of the remaining equipment is insufficient to supply domestic consumption, the deficiency must be made up by drawing on storage. The result is that unless the amount of water stored is very large as compared with the daily consumption, rapid depletion occurs. It may be said, therefore, that while storage may be quite effectively employed to offset a shortage in quantity, as has been previously pointed out, unless it is large it does not greatly affect the reliability of service.

Many plants have some equipment which is not regularly operated; this is particularly true of those which were originally run by steam and have been partially electrified. Normally idle equipment can not be considered reliable unless it is operated regularly, for the reason that valves and plungers become stuck, packing dries out, boiler gaskets leak, and no end of miscellaneous troubles develop. Changes in personnel frequently occur and we have found in some plants that new operators are not acquainted with the operation of the standby equipment. As a result of considerable experience along these lines, we have taken the stand that we will not recognize normally idle reserve equipment unless it is operated at four month intervals under actual working conditions for the approximate duration of one shift, and unless the operating data is completely recorded.

So far, only the mechanical aspects of the water supply system have been discussed. It is needless to say that no plant can be considered reliable in which the personnel is not competent, both to

operate and to make all ordinary repairs, nor can any plant be considered reliable in which routine tests for condition of the various component units are not made, or where complete plans and records are not compiled in such form as to be available for quick and convenient reference in an emergency.

(*Presented before the Wisconsin Section meeting*, Nov. 4–6, *1935*.)

IS YOUR WATER SUPPLY ADEQUATE FOR DOMESTIC AND INDUSTRIAL PURPOSES?

By Jerry Donohue

(Consulting Engineer, Sheboygan, Wis.)

A discussion of the development of an adequate water supply may be approached from many angles because of the variety of questions arising in connection with the solving of the problem of supplying good water for domestic and industrial purposes. That the need of an adequate water supply has long been felt by mankind is evidenced by the fact that water systems of a sort are as old as civilization.

The earliest way of artificially obtaining water was by excavating shallow cavities in low places which filled with water. As civilization advanced, it became necessary to obtain water in larger quantities for more concentrated populations. Then crude implements were used to dig shallow wells. Gradually as the tools were improved and the ingenuity of man increased, it was possible to dig deeper and deeper. There is still evidence of remarkable engineering work in Egypt, of wells drilled 300 feet into the solid rock. Historians tell us that water was raised from these wells by means of buckets attached to endless chains. There is evidence of (deep) wells exceeding 1000 feet in depth which were in use in ancient China.

These ancients were not only expert in the art of well drilling; they were good hydraulic engineers as well. They constructed works to store water and to convey it for long distances. In Jerusalem underground reservoirs were built for the storage of rainwater. Underground reservoirs have been unearthed in ancient Carthage which were supposed to have been built prior to the capture of that city by the Romans. Irrigation systems in Egypt, Syria, and India were established to make possible the raising of crops on soil which would otherwise have been barren. The Romans were perhaps the greatest of the ancient hydraulic engineers with more than three hundred miles of aqueducts—a monument to their skill supplying the city of Rome with water.

It was not until the latter part of the seventeenth and the early part of the eighteenth centuries that pumps came into general use for

the purpose of delivering water. By that time Paris had a fairly good system of distribution, but the volume was limited to two and a half quarts per capita per day.

The application of steam to water pumping in the eighteenth century gave definite impetus to the development of water works. By 1890 the daily per capita consumption in Paris had increased to 65 gallons but 49 gallons of this were drawn from the river and used for street washing and the other 16 gallons were taken from springs for domestic purposes.

In this country the earliest water works systems, built about 1650, consisted of gravity flows from springs. The water pipes were logs with a 5-inch bore through the center. The perfection of cast iron pipe was another major step in the development of water supply systems.

According to our present day standards, in determining whether or not a water supply is adequate for domestic and industrial purposes, the following points must be taken into consideration:

1. Is the water biologically pure, and free from objectionable odors, taste and sediment.

2. Does the distribution equipment handle the normal service efficiently and can it take care of a peak load when necessary.

3. Is the water free from injurious hardness?

4. Is the volume of supply great enough to serve the demand?

A water supply may be pure, and good for domestic purposes and still not be the best water for industrial use because of the large quantity of solids in solution. On the other hand, the water in the rain barrel was ideal in that it contained little if any hardness, but it was long on propagating wigglers.

Since 1900 the most important improvement added to municipal water works systems is the removal of the impurities from the water. In the early days before our lakes and streams were polluted with filth and sewage, water filtration plants were not necessary, but when a city receives its water supply from a lake or stream into which it empties its refuse, it is imperative for that city to purify its water in order to protect the good health of its citizens.

The distribution of water has been developed to a point where it is now possible for any citizen in almost any community of 1000 people or more to have pure water available for domestic use upon the turn of a faucet. If that citizen were to figure the cost of this water to him, he might be surprised to find that it is the cheapest commodity that he can buy, even cheaper than dirt.

The amount of hardness in a water supply is dependent almost entirely upon where that supply comes from. Surface waters are usually soft and contain little dissolved mineral. Hard water derives most of its mineral matter from the limestone and other sedimentary formations which give up their soluble content to the water passing through the fissures in the formations. An analysis of water drawn from municipal wells indicates that many of these waters carry a hardness in excess of 30 grains per gallon. That is, the encrusting solids carried in solution may run as high as 5 pounds per 1000 gallons of water. Lake Michigan water has a hardness of approximately 6 grains per gallon or less than one pound of encrusting solids per 1000 gallons of water.

A hardness not in excess of 6 grains per gallon or 102.6 p.p.m. is satisfactory. (And even desirable because the water is more palatable.) The iron content should not exceed 0.4 p.p.m., as a greater amount may cause iron spots to appear on the plumbing fixtures.

In domestic use, hardness has to be overcome by the use of a much greater amount of soap. It then becomes an economic problem as to how much the average family can afford to spend for soap in overcoming excessive hardness as against the municipality's developing a softer water supply or installing water softening equipment. In industry, the scale in boilers and heating plants is such a common source of trouble and expense that almost all large boiler plants have found it necessary to install individual water softening devices. When the amount of water used is too small to warrant the installation of individual equipment, the boilers suffer from lack of this important attention. Research engineers have estimated that the cost of boiler operation is increased 13 percent for every pound per 1000 gallons of scale or encrusting hardness in the water used.

There is no fixed or empirical rule by which a community can determine what the volume of its water supply should be. There are many contributing factors of a contingency nature that prevent an engineer's using the same rule in all cities. The total water demands of any community must be estimated by taking into consideration the following important factors:

1. *Fire protection.* A sufficient storage in reserve should be provided which is large enough to supply the maximum short time demand in case of fire. The coöperation of the inspection rating bureau should be invited and plans involving fire protection should be discussed with the rating bureau and their criticism obtained.

2. *Domestic requirements.* The domestic requirements may be computed upon a per capita basis, but the same per capita unit may not apply to all communities and this factor should be given special study.

3. *Industrial load.* The demand for industrial water may be estimated by making a study of the particular industries which require water. Canning plants, condenseries, tanneries and the like require larger volumes than other industries.

4. *Lawn sprinkling and garden irrigation.* This demand may be approximated by surveys of the particular community under study. The character of the homes and gardens and their requirements may be approximated by a study of conditions in cities where such data are available.

5. *Street flushing.* The volume available for street flushing may depend upon the climatic conditions, areas of streets, and standards of cleanliness established by the particular community. Street sprinkling should now be called street flushing for the old days of the street sprinkler to settle the dust have been largely substituted by the modern street flusher which actually washes the street surfaces.

A reasonable percentage of the total pumpage should be estimated for losses and leakages. The above may show that some communities will require as little as 50 gallons per capita per day, and still others as high as 300.

Where the supply is unlimited, a more general use of water for sprinkling and street flushing should be encouraged. Where the supply is limited to the amount that may be obtained from a deep well, the problem of supply may become a question of storage or it may go farther by actually limiting the use of water to the necessities of domestic consumption and sanitation.

In drilling a deep well there is a decided element of luck in obtaining an adequate supply. We have in this part of the State five underlying strata which produce water. In addition we also have the overlying glacial drift which is useful where it is not subjected to surface polution. We have wells in the Niagara limestone (which outcrops in Sheboygan on North Point) that produce 500 g.p.m. There are other wells in the same stratum in the same general area producing only 10 g.p.m. The St. Peter sandstone, which geologists tell us was a blown sand formed on the beaches of a prehistoric ocean, is usually good for a copious supply of water, but not so dependable as the underlying Potsdam which was a marine deposit.

A community may start out with a perfect intention of drilling to the Potsdam and then find that Nature played an early trick on that geological section by creating a knob in the early igneous formations and projecting this knob above the sea, so that when drillers reach 1200 feet or more, they encounter granite. The water supply of the section so handicapped by Nature must of necessity be very limited until they can hook up with a supply from some other source such as Lake Michigan or Lake Superior.

When an engineer is called in to make a study to determine whether or not a supply is adequate, he has two types of problem to face. One is finding a supply and making it available as has just been discussed. The other is increasing or improving the service for the community already provided with a water supply system.

SHEBOYGAN SUPPLY

In the case of Sheboygan, which takes its water from Lake Michigan, and, therefore, has a limitless volume of water on hand, the problem was first to provide for a pure water and next to provide for suitable storage in order to insure proper service during the times of a peak load. The first was accomplished by chlorination and the building of the filtration plant; the second by the erection of the reservoir on Taylor Hill three miles west of the business section.

Sheboygan takes its water from Lake Michigan through an intake extending 5000 feet into the lake. Prior to the installation of the filtration plant, the water was pumped directly into the mains and kept under constant pressure by continuous pumping. After the filtration plant had been put into service and raw water was no longer admitted into the distribution system, it became apparent to engineers that the addition of a storage reservoir would be necessary particularly because hourly peak loads on the system were increasing. The average citizen and many intelligent business men could not understand why storage was necessary with the lake right at our doors, but when the problem was explained to them and the figures developed to show the economy of the investment, not a word of protest was heard. The four million gallon reservoir, built in 1930, floats on the line and is connected to the system of the City by a 30-inch cast iron main.

THE GREAT LAKES

Although Wisconsin in general is particularly fortunate in having within reach a pure and wholesome water supply, both in the sedi-

mentary rock formations and in the inland lakes, the Great Lakes are the principal and most valuable source of supply. Lake Michigan and Lake Superior are available to a large portion of the State and to much more than 50 percent of the State's population. I say "are available" because it would be a comparatively simple hydraulic problem to connect these lakes to the inland cities by a system of water distribution. Compare the project of extending pressure lines across Wisconsin to the work now under construction in the far West where a 5000-foot mountain range separates Los Angeles from her source of future water supply. Why should not Sheboygan, for example, furnish water to the neighboring inland cities? The water could be delivered into a system of pressure mains for a reasonable cost. It would be a water containing approximately 6 grains of hardness as against 30 to 40 grains in well water taken from the lower formations. The smaller municipalities could provide for their own storage for emergencies in case of fire. Such a system is just as feasible as a system of high tension distribution of electrical energy or a pressure distribution of gas. Lake Michigan would furnish an inexhaustible supply and we who have thrived on Lake Michigan water believe that it is as good as any that can be drawn from the earth.

The water works superintendent of this and the next generation will be much concerned with the new developments tending to give a better service at a cheaper rate, and these developments may mean abandoning one source of supply for another which in the long run will provide better water at less cost.

No matter how honest we may be in calling a water supply adequate at the present time because of sufficient storage and more efficient equipment, we would hesitate to guarantee that the system will be adequate tomorrow because changes are being made so rapidly that we, as engineers, may be called upon overnight to provide additional capacity due to more demands for service to meet the advance of civilized requirements. Just as this scientific age has improved the automobile and then had to build better highways to keep pace with the improved vehicle, it is expected that we may be called upon to improve and enlarge our water systems to take care of such improvements as air conditioning in our homes and kitchen garbage grinders which will dispose of the garbage directly into the sewer system—all this in addition to water for drinking, sanitary uses, sprinkling the garden and the numerous other uses to which we have become accustomed since the installation of water in our homes.

The scientific changes which always follow the period of research in all branches of science, may be extended to add more comfort to our homes and permit the next generation to take advantage of and find new usefulness in our water works systems which we do not enjoy and of which our forefathers certainly never dreamed.

(Presented before the Wisconsin Section meeting, November 4-6, 1935.)

GRAND RIVER WATER SUPPLY AND FLOOD PREVENTION

By F. P. Adams

(*City Engineer, Brantford, Ontario, Can.*)

The Grand River Valley in South Western Ontario is the most thickly populated area in the Province. Its industries cover a wide range of manufactures including textiles, leather goods, light and heavy steel industries, milling and food and animal products of all descriptions.

The pollution of the river from industrial wastes and domestic sewerage, combined with a serious reduction of the summer flow, has brought about a condition that will require remedial measures if the continued prosperity of the district is to be assured.

The river and its tributaries drain an area of highly productive agricultural lands which have been improved by drainage. Permanent highways connect the towns and cities in its watershed with drainage ditches which carry the water from rains and melting snows quickly to the streams. Forests have been cut down and the land cleared to provide productive farm lands and the swamps which formerly provided summer storage at the headwaters of the river have been cut through by large Government drains which carry their waters off quickly in the spring.

These conditions have resulted in devastating floods during the spring run-off with corresponding low flows during the summer and early fall months.

The Grand River and its tributaries, the Nith, the Speed and the Conestoga, drain an area of 2600 square miles. It flows in a southerly direction through the counties of Dufferin, Wellington, Waterloo, Brant and Haldimand and empties into Lake Erie at Port Maitland. The drainage basin is about 120 miles in length with a width of from 10 to 40 miles and situated in the watershed and depending upon it for their water supplies and sewage disposal, are the municipalities of Fergus, Elora, Kitchener, Waterloo, Hespeler, Preston, Galt, Paris, Guelph, Brantford and Caledonia, in addition to large numbers of smaller towns and villages.

Several of the larger municipalities have spent considerable sums on dyking the river banks to prevent annual damage to property and loss of life from the spring floods which rush down the valley, Brantford alone having spent about $450,000.00 to date for this purpose.

In 1931 conditions had become so alarming that the Grand River Valley Board of Trade, an organization composed of representatives from practically all the municipalities along the river, made representations to the Provincial Government for assistance in preparing plans to combat the flood menace and to maintain a summer flow in the river which would be adequate for the needs of the district.

The work was undertaken under the direction of the Hon. William Finlayson, Minister of Lands and Forests, who with the consent of the Ontario Hydro Electric Power Commission, appointed Mr. T. H. Hogg, Chief Hydraulic Engineer for the Commission; Mr. L. V. Rorke, Surveyor General for Ontario, was associated with Mr. Hogg to make the necessary investigation and report. Mr. James MacKintosh of the staff of the Hydro Commission was deputed to carry out the field work and prepare the necessary data.

The Report on the Grand River Drainage was completed in 1932. The physical aspects of the area were surveyed, temperatures, rainfall, snowfall and stream run-off were determined and the natural storage of the watershed was ascertained. Much valuable information was obtained from gauging stations which had been established at various points along the river in 1912, after a similar effort had been made by the municipalities interested at that time.

It was found that there is a drop of 1128 feet in the river from its source in the Highlands of Ontario to its outlet into Lake Erie with average grades as follows:

	Slope, feet per mile
From Port Maitland to Brantford	0.87
From Brantford to Elora	6.7
From Elora to Dundalk	11.2

The grades of its principal tributaries are:

	Length, miles	*Slope, feet per mile*
The Nith River	72	7.1
The Speed River	24	10
The Conestoga River	40	13

The average rainfall over the district is 33 inches, being 35 inches along its westerly edge and 32 inches along its easterly edge.

The average snowfall at Brantford is 45 inches increasing to 90 inches at the headwaters of the river.

Run-off is the amount of water which the drainage basin carries to the open stream. It is the total rainfall over the area of the drainage basin minus the water evaporated by the sun's rays; the transpiration of herbage and deep seepage which does not find its way to the stream but sinks to lower levels. The run-off of the river above Galt is about 35 percent of the total rainfall.

If the run-off of the drainage basin were distributed uniformly throughout the year there would be no problem, but unfortunately this is not the case. Due to inadequate natural storage the spring run-off brings down the melting snows and spring rains in tremendous volume causing disastrous floods.

The average annual run-off of the river above Galt is 1500 cubic feet per second. At times the spring run-off is 20 times this amount. During the summer the flow of the river is at times as low as 50 cubic feet per second.

To remedy this condition it is proposed to construct four impounding reservoirs on the river and its tributaries each with a storage capacity of 10,000 acre feet, and in addition, to dam back the headwaters of the river at its outlet from the Luther marsh by means of a low dam, which would add an additional 10,000 acre feet to the storage waters.

The reservoirs would be formed by the construction of dams across the river valley approximately 50 feet in height. They would control floods by holding back excessive run-off at critical times and releasing the waters during the dry summer months. The locations of these reservoirs are on

The Grand River below the village of Waldemar.

The Grand River below the town of Elora.

The Conestoga River below the village of Hollen.

The Conestoga River near its junction with the Grand River.

It is recommended that these works be proceeded with by stages over a period of years.

The different stages of development, the reduction in flood levels, the minimum stream flow and the estimated capital costs are set out in table 1.

The spring flood of the year 1929 is taken as a typical example of a severe flood which can be expected to occur at frequent intervals. Heavier floods may be anticipated as conditions of temperature,

rainfall, and the accumulation of snow occur in sequences favourable for flood conditions.

The water supply for the towns and cities in the drainage area of the river depends primarily upon the flow of the river. Galt and Fergus obtain their water from wells drilled in the rock in the vicinity

TABLE 1

STAGE OF DEVELOPMENT	LOCATION	ACRE FEET	REDUCTION IN 1929 FLOOD: Galt C.F.S.	Galt Ft.	Brantford C.F.S.	Brantford Ft.	REGULATED LOW FLOW: Galt	Brantford	CAPITAL COST, DOLLARS
1	Luther Waldemar	10,000 10,000	5,000	2.5	7,500	1.3	200	320	673,000
2	Luther Waldemar Hollen	10,000 10,000 10,000	10,000	4.0	10,500	2.0	220	350	1,359,000
3	Luther Waldemar Hollen Conestoga No. 2	10,000 10,000 10,000 10,000	12,500	5.0	14,500	2.9	290	430	2,150,000
4	Luther Waldemar Hollen Conestoga No. 2 Elora	10,000 10,000 10,000 10,000 10,000	15,000	5.6	18,500	3.6	350	500	2,955,000

A complete survey has been made of the Waldemar Dam project by the Department of Lands and Forests, and plans of the proposed dam prepared by the Hydro Electric Power Commission. The rock levels at the site of the dam were ascertained by test pits.

Estimates based on this accurate data show that the original estimates given in the report are quite accurate.

of the river and they depend upon infiltration from the river for their supply.

Kitchener and Waterloo obtain their water from wells in the underlying gravel and the upper rock strata. The supply to these wells comes from deep seepage of rainfall and infiltration from the river. Brantford obtains its supply directly from the river while Paris depends upon wells in the gravel near the Speed at its junction with the Grand.

As these Municipalities grow in population they will eventually graduate from a well supply, as has Brantford, and place their dependence on a river supply in order to obtain quantities sufficient for their needs.

The summer flow of the river also has a distinct bearing on the water supply to farmer's wells in the valley.

The relation of the stream flow of the Grand River to sewage disposal is of immediate importance to the health and well being of the Municipalities along its course.

The river is the final means of disposal of all effluent from sewage and trade wastes of the municipalities and an increased summer flow is essential to the proper dilution of the effluents from sewage disposal plants in order that they do not become a nuisance to the inhabitants situated below such disposal plants, and to preserve the waters of the river in such a condition that they may be capable of treatment for domestic supplies.

The question of reforestation is dealt with in the report and it is recommended that on lands unsuitable for agricultural purposes in the watershed that they be planted out to suitable varieties of trees as a means of assisting in the conservation of natural springs and impeding the quick run off of surface waters, but due to the highly fertile nature of the greater portion of the lands and their high degree of development for agricultural purposes, it would not be economically possible to turn back these lands to their original forest growths.

The individual municipalities can only deal with those matters in connection with the river improvements which affect them locally. They can erect dykes to protect themselves from floods, and construct sewage disposal plants to treat their wastes. This they have done to the limit of their ability. It requires now the intervention of some central authority to carry out the larger program of works necessary to obtain for this densely populated area the protection to its health and safety necessary for its continued development.

An appeal is made to the Federal and Provincial Governments for consideration of these matters in their program of relief works designed to put more of our unemployed citizens to work. No type of construction will confer greater or more lasting benefits to large densely populated areas than the conservation and control of their water supplies.

(Presented before the Canadian Section meeting, April 1, 1936.)

TYPHOID FEVER IN THE LARGE CITIES OF THE UNITED STATES IN 1935[1]

This report deals with the same ninety-three cities that have been discussed in the corresponding articles for the years beginning with 1930. The number of deaths from typhoid during 1935 in each city (except Scranton, as explained in a note to table 2) has been supplied by the respective health department. The United States Bureau of the Census is working out a new method for estimating the populations of the large cities in view of the extraordinary changes in urban and rural distribution since 1930; but as such estimates are not yet available the rates in the present article are based on the same population figures as were used for the 1934 rates; namely, the estimates for midyear 1933 as computed by the Bureau of the Census according to a method described in our last year's report.

Deaths from paratyphoid, when these were specified in the reports made to us by a health department, have been excluded from the deaths on which we have based the typhoid death rate. This follows the distinction set by the latest edition of the Manual of International Causes of Death (edition 4, 1931); in the previous edition (1921) typhoid and paratyphoid were grouped together. The paratyphoid deaths thus excluded, beginning with 1931, have been as follows: Cleveland, one paratyphoid death in 1931 (thirty-one typhoid deaths); Jacksonville, one paratyphoid death in 1933 (one typhoid death also in that year);[2] Knoxville, two paratyphoid deaths

[1] Reprinted from the Journal of the American Medical Association, 106: 23, June 6, 1936, p. 1983.

The preceding articles in this series were published in the same journal, May 31, 1913, p. 1702; May 9, 1914, p. 1473; April 17, 1915, p. 1322; April 22, 1916, p. 1305; March 17, 1917, p. 845; March 16, 1918, p. 777; April 5, 1919, p. 997; March 6, 1920, p. 672; March 26, 1921, p. 860; March 25, 1922, p. 890; March 10, 1923, p. 691; Feb. 2, 1924, p. 389; March 14, 1925, p. 813; March 27, 1926, p. 948; April 9, 1927, p. 1148; May 19, 1928, p. 1624; May 18, 1929, p. 1674; May 17, 1930, p. 1574; May 9, 1931, p. 1576; April 30, 1932, p. 1550; May 13, 1933, p. 1491; May 19, 1934, p. 1677, and June 8, 1935, p. 2093.

[2] The Jacksonville typhoid death rate for 1933 was erroneously figured without excluding the paratyphoid death. Its correct 1933 rate should there-

in 1935 in addition to six typhoid deaths; New Haven, one paratyphoid death in 1934 and one in 1935 (no typhoid death in either year); New York, one paratyphoid death in 1931 (seventy-six typhoid);[3] Oakland, two paratyphoid deaths in 1934 (also two typhoid deaths); Wichita, two paratyphoid deaths in 1935 (no typhoid deaths); Wilmington, one paratyphoid death in 1932 (also one typhoid death in that year).

TABLE 1

Death rates of fourteen cities in New England States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Fall River	0.2*	2.2	2.3	8.5	13.4	13.5	0.9	0.0	0.0
Lynn	0.2	1.5	1.6	3.9	7.2	14.1	1.0	0.0	0.0
Bridgeport	0.3	0.5	2.2	4.8	5.0	10.3	0.0	0.0	0.7
Somerville	0.4	1.3	1.6	2.8	7.9	12.1	0.0	0.0	1.9
Waterbury	0.4	1.2	1.0	8.0	18.0	....	2.0	0.0	0.0
Boston	0.6	1.2	2.2	2.5	9.0	16.0	0.5	0.9	0.2
Worcester	0.6	1.0	2.3	3.5	5.0	11.8	0.5	0.0	0.5
New Haven	0.7	0.6	4.4	6.8	18.2	30.8	0.0	0.0	1.2
Cambridge	0.9	2.1	4.3	2.5	4.0	9.8	0.0	0.9	1.8
Lowell	1.0*	2.6	2.4	5.2	10.2	13.9	1.0	0.0	1.0
Springfield	1.0	0.4	2.0	4.4	17.6	19.9	0.0	0.0	0.6
New Bedford	1.1*	1.5	1.7	6.0	15.0	16.1	0.0	1.8	1.8
Providence	1.1	1.3	1.8	3.8	8.7	21.5	0.8	1.2	1.2
Hartford	1.2	1.3	2.5	6.0	15.0	19.0	0.6	0.6	0.6

* Rate computed from population as of April 1, 1930, as no estimate for July 1, 1933, was made by the Census Bureau.

The problem of including in the rates for each city the typhoid rate for nonresidents is still conspicuous. In twenty-four of the ninety-three cities we are informed that one-third or more of the

fore be 0.7 instead of 1.4. The following corrections should be made in the tables in the 1933 article: tables 3 and 9, change Jacksonville rate to 0.7; table 10, for 1933 the number of cities with rates 1.0 to 1.9 is 18, with rates 0.1 to 0.9 is 34; table 11, third footnote, total typhoid deaths number 469; table 12, South Atlantic typhoid deaths number 54 and the group rate is 2.28.

[3] The paratyphoid death in New York in 1931 was included by mistake in the total deaths on which the typhoid rate was calculated. Its exclusion does not change the New York rate for the year (1.1) or the Middle Atlantic group rate (1.06) but it lessens by one the totals for the country in tables 11 and 12 in the article covering the year 1931.

typhoid deaths were in nonresidents. These are indicated in table 9 and should be also referred to in examining tables 1 to 8.[4] Complete data are unavailable for a few cities as described (tables 2 to 8, "incomplete data") in the report covering the year 1932.

Six of the large New England cities had no typhoid deaths in 1935 (table 1), four of them for the second year in succession. The quinquennial average 1931–1935 is particularly interesting since it

TABLE 2

Death rates of eighteen cities in Middle Atlantic States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Jersey City	0.2	0.9	2.7	4.5	7.2	12.6	0.0	0.0	0.3
Newark	0.3	0.9	2.3	3.3	6.8	14.6	0.0	0.2	0.4
Reading	0.4	1.6	6.0	10.0	31.9	42.0	0.9	0.0	0.0
Rochester	0.4	1.7	2.1	2.9	9.6	12.8	0.3	0.0	0.3
Buffalo	0.6	2.7	3.9	8.1	15.4	22.8	0.5	0.3	0.3
Utica	0.6	1.1	3.9*	...	...	...	1.0	0.0	0.0
Yonkers	0.7	0.5	1.7	4.8	5.0	10.3	1.4	0.0	0.0
New York	0.8	1.3	2.6	3.2	8.0	13.5	0.5	0.6	0.9
Syracuse	0.8	0.8	2.3	7.7	12.3	15.6	0.5	0.5	1.8
Elizabeth	0.9	1.6	2.4	3.3	8.0	16.6	0.0	0.0	0.0
Philadelphia	0.9	1.1	2.2	4.9	11.2	41.7	0.9	0.9	0.6
Pittsburgh	0.9	2.4	3.9	7.7	15.9	65.0	0.6	1.5	0.1
Paterson	0.9	1.0	3.3	4.1	9.1	19.3	0.0	0.7	0.0
Erie	1.0	0.9	2.3	6.9	49.0	46.6	0.0	1.7	0.9
Albany	1.1	1.8	5.6	8.0	18.6	17.4	0.8	0.8	0.8
Trenton	1.1	2.1	8.2	8.6	22.3	28.1	0.0	0.8	2.4
Scranton	1.4	1.8	2.4	3.8	9.3	31.5	0.0†	0.0	3.4
Camden	2.8	4.4	5.9	4.9	4.5	4.0	2.5	1.7	3.3

* Incomplete data.

† Typhoid deaths for Scranton furnished by Pennsylvania Department of Health, Harrisburg.

shows that all but two of the New England cities (New Haven, Springfield) had lower average rates than for the preceding five years. Bridgeport has had the lowest average rate for the ten-year period 1926–1935. The New England group as a whole (population

[4] The problem of the nonresident has been discussed at some length in our previous reports; for example, J. A. M. A. **100**: 1491, May 13, 1933 and **98**: 1550, April 30, 1932.

TABLE 3

Death rates of nine cities in South Atlantic States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Baltimore	1.4	3.2	4.0	11.8	23.7	35.1	1.5	1.3	0.4
Wilmington	1.5	3.1	4.7	25.8*	23.2*	33.0	0.9†	1.9	1.9
Jacksonville	1.7	4.4	....	....	....	....	0.0	1.4	0.7‡
Miami	2.2	3.5	....	....	....	....	2.8	1.8	2.7
Richmond	2.5	1.9	5.7	9.7	15.7	34.0	2.7	3.8	1.6
Washington	2.6	2.8	5.4	9.5	17.2	36.7	2.6	1.6	3.6
Tampa	3.0	3.8	19.1	43.9*	....	....	6.6	0.0	1.8
Norfolk	4.2	2.2	2.8	8.8	21.7	42.1	5.4†	5.4	3.8
Atlanta	7.2	11.1	14.5	14.2	31.4	58.4	4.6	3.9	6.0

* Incomplete data.

† Rate computed from population as of April 1, 1930, as no estimate for July 1, 1933, was made by the Census Bureau.

‡ This rate in our two previous articles was given as 1.4, owing to the erroneous inclusion of one paratyphoid death.

TABLE 4

Death rates of eighteen cities in East North Central States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Grand Rapids	0.2	1.0	1.9	9.1	25.5	29.7	0.0	0.0	0.0
Milwaukee	0.2	0.8	1.6	6.5	13.6	27.0	0.0	0.2	0.3
Chicago	0.4	0.6	1.4	2.4	8.2	15.8	0.4	0.6	0.3
Detroit	0.6	1.3	4.1	8.1	15.4	22.8	0.3	1.1	0.6
Flint	0.7	1.6	4.6	22.7	18.8	46.9	0.6	1.2	0.0
South Bend	0.7	....	....	....	....	....	0.9	1.8	1.0
Akron	0.8	1.5	2.4	10.6	21.0	27.7*	0.7	0.4	1.1
Dayton	0.8	1.9	3.3	9.3	14.8	22.5	1.0	1.0	0.5
Canton	0.9	1.4	3.3	8.9	....	....	0.9	0.9	0.0
Peoria	0.9	0.2	3.7	5.7	16.4	15.7*	0.0	0.0	0.9
Cleveland	1.1	1.0	2.0	4.0	10.0	15.7	0.6	0.8	0.5
Youngstown	1.1	1.1	7.2	19.2	29.5	35.1	0.0	0.6	2.3
Indianapolis	1.2	2.7	4.6	10.3	20.5	30.4	1.3	1.1	0.5
Toledo	1.3	3.0	5.8	10.6	31.4	37.5	1.3	1.3	1.3
Cincinnati	1.4	2.5	3.2	3.4	7.8	30.1	1.3	1.5	0.9
Evansville	1.9	6.2	5.0	17.5	32.0	35.0	4.7	1.9	0.0
Columbus	2.0	2.1	3.5	7.1	15.8	40.0	2.0	2.0	1.7
Fort Wayne	2.2	4.2	12.9	7.3	....	....	0.0	6.7	0.0

* Incomplete data.

2,624,805) recorded for 1935 the lowest group rate (0.49) yet reached by that group and also the lowest ever recorded by any of the eight geographic divisions. This is the seventh year of progressive decline in the typhoid group rate for the New England cities (table 12).

TABLE 5

Death rates of six cities in East South Central States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Louisville	2.3	3.7	4.9	9.7	19.7	52.7	1.6	2.5	1.9
Birmingham	3.9	8.0	10.8	31.5	41.3	41.7	4.0	5.8	4.0
Chattanooga	4.7	8.0	18.6	27.2	35.8*	....	2.4	8.1	3.2
Nashville	5.6	18.2	17.8	20.7	40.2	61.2	7.0	2.6	7.6
Knoxville	5.7	10.7	20.8	25.3*	....	....	5.4	0.9	7.1
Memphis	7.9	9.3	18.9	27.7	42.5	35.3	5.0	8.4	7.6

* Incomplete data.

TABLE 6

Death rates of nine cities in West North Central States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
St. Paul	0.7	1.4	3.4	3.1	9.2	12.8	0.3	0.0	1.4
Wichita	0.7	1.2	6.3	....	....	....	0.0	0.0	1.7
Minneapolis	0.8	0.8	1.9	5.0	10.6	32.1	1.2	1.2	0.2
Omaha	0.9	1.3	3.3	5.7	14.9	40.7	0.0	0.9	0.5
Duluth	1.0	1.1	1.7	4.4	19.8	45.5	1.0	1.0	1.0
Kansas City, Kan	1.1	1.7	5.0	9.4	31.1	74.5*	1.6	1.6	0.8
Kansas City, Mo	1.5	2.8	5.7	10.6	16.2	35.6	1.0	1.4	2.4
St. Louis	1.6	2.1	3.9	6.5	12.1	14.7	0.7	1.7	2.2
Des Moines	2.1	2.4	2.2	6.4	15.9	23.7	2.1	6.2	2.0

* Incomplete data.

The Middle Atlantic cities (table 2) have likewise had for the past four years a group rate under 1.0, thus continuing a progressive decline. As in 1934, seven of the eighteen cities report the complete absence of typhoid deaths, Elizabeth for the fourth consecutive year. Scranton, which had the highest rate of the group in 1933, reported no typhoid deaths in 1934 or 1935. Jersey City likewise completes its second consecutive year without a typhoid death. Pittsburgh's

rate (0.6) is better than in 1934, although not equal to the conspicuously low rate (0.1) for 1933. The four cities in this group with a population of more than half a million all had rates under 1.0, New York for the fourth consecutive year, Philadelphia and

TABLE 7

Death rates of eight cities in West South Central States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Tulsa	1.1	8.3	16.2*	....	....	....	0.7	2.7	0.0
Houston	3.2	4.8	7.6	14.2	38.1	49.5*	2.2	2.8	4.0
San Antonio	4.2	4.6	9.3	23.3	29.5	35.9	3.3	4.9	4.9
Oklahoma City	4.3	7.4*	....	....	....	....	2.5	5.9	3.4
Fort Worth	4.6	5.9	6.1	16.3*	11.9	27.8	1.2	5.9	7.6
El Paso	4.9	9.1	10.8	30.7	42.8	....	7.6	3.8	2.8
Dallas	5.4	7.3	11.2	17.2	....	....	2.9	4.3	5.3
New Orleans	9.6	9.9	11.6	17.5	20.9	35.6	7.4	8.9	9.1

* Incomplete data.

TABLE 8

Death rates of eleven cities in Mountain and Pacific States from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1935	1934	1933
Long Beach	0.2	1.1	2.1*	....	....	....	0.0	0.6	0.6
Seattle	0.6	2.2	2.6	2.9	5.7	25.2	0.8	0.0	0.8
Tacoma	0.7	1.8	3.7	2.9	10.4	19.0	0.0	0.0	0.0
Los Angeles	0.8	1.5	3.0	3.6	10.7	19.0	0.9	1.0	0.6
Portland	0.8	2.3	3.5	4.5	10.8	23.2	1.6	0.6	0.0
San Francisco	0.8	2.0	2.8	4.6	13.6	26.3	0.8	0.1	0.1
Oakland	1.0	1.2	2.0	3.8	8.7	21.5	1.7	0.7	0.7
Salt Lake City	1.0	1.9	6.0	9.3	13.2	41.1	1.4	1.4	0.0
San Diego	1.3	1.0	1.6	7.9	17.0	10.8	0.0	1.2	4.3
Spokane	1.4	2.2	4.4	4.9	17.1	50.3	0.8	2.6	0.9
Denver	1.8	2.6	5.1	5.8	12.0	37.5	0.7	1.4	2.7

* Incomplete data.

Buffalo for the third. The typhoid rate in Camden still ranked highest in 1935, as did its average for the quinquennial period.

One of the South Atlantic cities (Jacksonville) reports no typhoid deaths in 1935. Atlanta's rate (4.6), while higher than 1934 (3.9),

TABLE 9

Death rates from typhoid in 1935

Honor Roll: No Typhoid Death (Twenty-four Cities)

Bridgeport	Long Beach	San Diego
Cambridge	Milwaukee	Scranton
Elizabeth	Newark	Somerville
Erie	New Bedford	Springfield
Fort Wayne	New Haven	Tacoma
Grand Rapids	Omaha	Trenton
Jacksonville	Paterson	Wichita
Jersey City	Peoria	Youngstown

First Rank: from 0.1 to 1.9 Deaths per Hundred Thousand

(Forty-Seven Cities)

Detroit	0.3	Tulsa	0.7	Lowell	1.0
Rochester	0.3*	Albany	0.8	Lynn	1.0
St. Paul	0.3	Providence	0.8	Utica	1.0*
Chicago	0.4	San Francisco	0.8†	Fort Worth	1.2
Boston	0.5	Seattle	0.8†	Minneapolis	1.2
Buffalo	0.5†	Spokane	0.8	Cincinnati	1.3
New York	0.5	Canton	0.9	Indianapolis	1.3
Syracuse	0.5	Fall River	0.9	Toledo	1.3
Worcester	0.5	Los Angeles	0.9†	Salt Lake City	1.4†
Cleveland	0.6†	Philadelphia	0.9	Yonkers	1.4
Flint	0.6	Reading	0.9	Baltimore	1.5†
Hartford	0.6	South Bend	0.9	Kansas City, Kan.	1.6
Pittsburgh	0.6	Wilmington	0.9	Louisville	1.6
Akron	0.7†	Dayton	1.0*	Portland	1.6
Denver	0.7	Duluth	1.0	Oakland	1.7†
St. Louis	0.7	Kansas City, Mo.	1.0		

Second Rank: from 2.0 to 4.9 (Fifteen Cities)

Columbus	2.0†	Camden	2.5†	Dallas	2.9†
Waterbury	2.0	Oklahoma City	2.5	San Antonio	3.3†
Des Moines	2.1	Washington	2.6	Birmingham	4.0†
Houston	2.2	Richmond	2.7	Atlanta	4.6†
Chattanooga	2.4	Miami	2.8†	Evansville	4.7

Third Rank: from 5.0 to 7.6 (Seven Cities)

Memphis	5.0†	Tampa	6.6	New Orleans	7.4†
Knoxville	5.4†	Nashville	7.0†	El Paso	7.6†
Norfolk	5.4				

* All the typhoid deaths reported were stated to be in nonresidents.

† One third or more of the reported typhoid deaths were stated to be in nonresidents.

is still well below the other rates of recent years and the city again, as in 1934, no longer occupies its long held position in the highest rank in the country. Atlanta hospitals serve a 40-mile radius from the city, so that the proportion of nonresident deaths is large. Baltimore had about the same rate (1.5) in 1935 as in 1934 (1.3), but four of the twelve deaths are stated to be in nonresidents. The group rate for the South Atlantic cities (2.58) is slightly higher than for the three preceding years, but its quinquennial average 1931–1935 shows a marked improvement over the preceding five year period.

After the decided increase in typhoid mortality which occurred in the cities of the East North Central group (table 4) in 1934, the rate

TABLE 10

Number of cities with various typhoid death rates

	NUMBER OF CITIES	10.0 AND OVER	5.0 TO 9.9	2.0 TO 4.9	1.0 TO 1.9	0.1 TO 0.9	0.0
1916–1910	77	75	2	0	0	0	0
1911–1915	79	58	19	2	0	0	0
1916–1920	84	22	32	30	0	0	0
1921–1925	89	12	17	48	12	0	0
1926–1930	92	3	10	30	37	12	0
1931–1935	93	0	6	17	28	42	0
1930	93	2	6	30	23	22	10
1931	93	2	6	23	28	22	12
1932	93	1	7	13	29	29	14
1933	93	0	7	18	19	33	16
1934	93	0	9	11	27	23	23
1935	93	0	7	15	18	29	24

has dropped back almost to the 1933 level, with fifty-eight deaths in 1935 as against eighty-eight and fifty-four in 1934 and 1933 respectively. Five cities had clear typhoid records in 1935, and twelve had rates under 1.0 as against eight in 1934. Three cities had higher typhoid rates in 1935 than in 1934, the most noteworthy increase being in Evansville following four years of little or no typhoid. Fort Wayne again has a clear record in 1935 after its bad year in 1934. Detroit has the lowest rate in its history (0.3). Chicago also continues to have a very low rate.

The six East South Central cities (table 5) had forty-nine typhoid deaths in 1935 as against sixty-one in both 1933 and 1934. Knox-

ville and Nashville, which showed decreases in 1934, had much higher rates in 1935. The other four cities reversed this picture.

TABLE 11

*Total typhoid rate for seventy-eight cities, 1910–1934**

	POPULATION	TYPHOID DEATHS	TYPHOID DEATH RATE PER 100,000
1910	22,573,435	4,637	20.54
1911	23,211,341	3,950	17.02
1912	23,835,399	3,132	13.14
1913	24,457,989	3,285	13.43
1914	25,091,112	2,781	11.08
1915	25,713,346	2,434	9.47
1916	26,257,550	2,191	8.34
1917	26,865,408	2,016	7.50
1918	27,086,696†	1,824†	6.73
1919	27,735,083†	1,151†	4.15
1920	28,244,878	1,088	3.85
1921	28,859,062	1,141	3.95
1922	29,473,246	963	3.26
1923	30,087,430	950	3.16
1924	30,701,614	943	3.07
1925	31,315,598	1,079	3.44
1926	31,929,782	907	2.84
1927	32,543,966	648	1.99
1928	33,158,150	628	1.89
1929	33,772,334	537	1.59
1930	34,386,717	554	1.61
1931	35,137,915	563	1.60
1932	35,691,815	442	1.24
1933	35,691,815	423	1.18
1934	35,401,715	413	1.17
1935	35,401,715	348	0.98‡

* The following fifteen cities are omitted from this table because data for the full period are not available: Canton, Chattanooga, Dallas, Fort Wayne, Jacksonville, Knoxville, Long Beach, Miami, Oklahoma City, South Bend, Tampa, Tulsa, Utica, Wichita, Wilmington.

† Data for Fort Worth lacking.

‡ The rate for the ninety-three cities in 1935 is 1.03 (total population 37,437,812, typhoid deaths 385), whereas in 1930 it was 1.64, and in 1933 and 1934 it was 1.24 and 1.25, respectively. The 1931–1935 average for the ninety-three cities is 1.31.

Louisville and Memphis record their lowest rates since 1930. Chattanooga dropped from 8.1 to 2.4. The group as a whole shows a

notable diminution of the typhoid average for the last five years (table 12).

In the West North Central cities (table 6) the typhoid mortality in 1935 was considerably less than in 1934, twenty-three deaths as against forty. It is to be noted, however, that the population in this geographic division is very close to that of the New England cities, while the number of typhoid deaths is nearly twice as great both for the years 1934 and 1935 (table 12) and for the quinquennial period. It is encouraging that the group rate for the West North Central cities for 1935 is for the first time under 1.0. Two of the nine

TABLE 12

Total typhoid death rate per hundred thousand of population for ninety-three cities according to geographic divisions

	(1933) POPULATION	TYPHOID DEATHS		TYPHOID DEATH RATES					
		1935	1934	1935	1934	1933	1931–1935	1926–1930	1925
New England...........	2,624,805	13	14	0.49	0.53	0.68	0.70	1.31	2.48
Middle Atlantic.........	12,952,300	72	82	0.55	0.63	0.78	0.80	1.40	2.97
South Atlantic..........	2,367,307	61	50	2.58	2.11	2.31	2.70	4.50	7.01*
East North Central.....	9,643,100	58	88	0.60	0.91	0.55	0.75	1.29†	2.32†
East South Central.....	1,242,600	49	61	3.94	4.91	4.91	4.81	8.31	13.00
West North Central....	2,704,500	23	40	0.85	1.48	1.51	1.24	1.83	3.43
West South Central.....	1,934,800	74	105	3.82	5.43	5.40	5.36	7.32‡	13.08‖
Mountain and Pacific...	3,968,400	35	30	0.88	0.75	0.82	0.88	1.80	2.33

* Lacks data for Jacksonville and Miami.

† Data for South Bend for 1925–1929 are not available.

‡ Lacks data for Oklahoma City in 1926.

‖ Lacks data for Oklahoma City.

cities, Omaha and Wichita, report no typhoid deaths in 1935, Wichita's being the second successive clear record and the fifth one in its history. Des Moines, after its abrupt rise in 1934, subsides to its 1933 level, but its typhoid mortality still ranks as the highest in the group.

The West South Central cities in 1935 showed a conspicuous improvement, with the lowest group rate (3.82) they have ever attained. These cities had only seventy-four typhoid deaths in 1935 as against 105 and 106 respectively in the two preceding years. With the single exception of El Paso, all the cities had lower rates in 1935 than in 1934. Tulsa continues to have the lowest rate in

the group, as it has had every year beginning with 1930, and its 1935 rate (0.7) is definitely lower than the abrupt increase shown in 1934. Two cities in this group, New Orleans and El Paso, had the highest rates in the country (7.4 and 7.6), as shown in table 9. Less improvement in this group than in the East South Central cities is shown also in the quinquennial average.

The cities in the Mountain and Pacific states (table 8) had a slight increase in typhoid mortality in 1935 as compared with 1934 (thirty-five deaths as against thirty) and for the first time since 1929 the decline in the group rate was halted. In 1935 three cities in this group record no typhoid deaths as against two in 1934. For Tacoma it is the second successive year of freedom from typhoid mortality and the third in its history. Long Beach had no typhoid deaths in 1935 or in 1931 or 1932. San Diego, which has a clear record in 1935, had no typhoid deaths also in 1930. Denver and Spokane have both improved their position in the group and San Francisco, while not equaling its remarkable record of 0.1 for 1933 and 1934, still makes an excellent showing (0.8), two of its five typhoid deaths being reported as in nonresidents.

Of the thirteen cities in the country with more than 500,000 population, all but Baltimore had 1935 typhoid rates below 1.0. Twenty-four cities had no typhoid deaths at all in 1934, the largest number with a perfect score yet reported. Six of these were New England cities and seven Middle Atlantic. Eleven of the twenty-four cities had had no typhoid deaths in 1934 and two of them (Elizabeth and Grand Rapids) have had no typhoid deaths in four years.

Eight cities (five of them in New England) had no deaths from either typhoid or diphtheria in 1935 (Bridgeport, Cambridge, Erie, New Bedford, New Haven, Scranton, Springfield, Tacoma). It is the second successive year that New Haven has had a clear record for both diseases, a record equaling that of Elizabeth for 1933 and 1934.

There are twenty-two cities in 1935 with rates of 2.0 or over (table 9, second and third ranks) as against twenty in 1934. The highest typhoid rate reported in any city is for the first time below 8.0. Of the twenty-two cities with 1935 rates of 2.0 and over, five are Northern cities (Camden, Columbus, Evansville, Des Moines, Waterbury).

The total of typhoid deaths for the ninety-three cities is notably

less in 1935 than in 1934 (385 as against 470). For the seventy-eight cities for which we have complete data since 1910 (table 11) the 1935 total of typhoid deaths is 348, as compared with 413 for the preceding year and the typhoid rate 0.98 as against 1.17.

In six of the eight geographic divisions of the country there were fewer typhoid deaths in 1935 than in 1934, slight increases occurring in the South Atlantic and the Mountain and Pacific groups. For the first time five of the eight groups registered rates below 1.0, and all are below 4.0.

SOCIETY AFFAIRS

THE ILLINOIS SECTION

The 28th Annual Meeting of the Illinois Section was opened at 10:00 o'clock Friday morning, April 10, 1936, by Chairman Wesley W. Polk, who after the call to order and a few brief remarks presented the Honorable Charles H. Bartlett, Mayor of Evanston.

Mayor Bartlett's address of welcome was most cordial.

Dr. A. M. Buswell was called upon in behalf of the Section to acknowledge the Mayor's welcome.

The first paper of the morning session entitled "The Engineering Situation in Water Works Engineering" was presented by Professor Harold E. Babbitt, College of Engineering, University of Illinois.

Discussion of the paper was presented by Mr. W. W. DeBerard and in the course of his remarks made the suggestion that a special committee be appointed by the incoming officers on Personnel and Education. In fact it appears that this is a fertile subject for consideration by the Board of Directors of the American Water Works Association.

The paper by Mr. H. R. Frye, Chemist in Charge of Filtration, entitled "Recent Improvements and Extensions in the Evanston Water System" was a most entertaining paper particularly the slides of the new elevated storage tanks. This paper was ably discussed by Mr. D. H. Maxwell.

A paper on "The Relative Importance of the Meter Division to the Water Department" was presented by Mr. LaVerne Trentlage, Superintendent of the Meter Department for the city of Elgin, Illinois.

The next address was entitled "The Water Works Superintendent's Place in Swimming Pool Operation," by Mr. Clarence W. Klassen, Acting Chief Sanitary Engineer, State Department of Public Health. The discussion was led by Mr. Charles H. Spaulding, Superintendent of the municipally owned Water, Light & Power Utility of Springfield, Illinois.

The last paper of the first session was presented by Mr. Carl H. Bauer, State Director, Public Works Administration for Illinois, on the P.W.A. activities in Illinois.

Recess for luncheon was taken at about 1:30 p.m.

At 12:00 noon the registration had reached 117 and after the first hour the attendance for the various papers was 100 or more.

Friday, April 10, 1936, Afternoon Session

The afternoon session was called to order by the Section Chairman at 3:00 p.m.

The first paper by Mr. R. T. Reilly of the firm of Alvord, Burdick and Howson, entitled "Relation between Sewage Disposal and Water Supply Protection for Cities Bordering on Lake Michigan" was a most excellent one and developed discussion by: James H. LeVon and Frank R. Shaw of the U. S. Public Health Service; L. H. Enslow, Editor, Water Works & Sewerage, and L. R. Howson of Alvord, Burdick & Howson.

Mr. C. M. Roos, Vice-President of the Cairo Water Company, presented a very thoughtful paper on "Operating Records," in which he called attention to the fact that records are of no use unless studied and used, and that such records should be in such manner and form as to be easily understood.

The troubles the Water Works Superintendent experienced on account of the prolonged low temperatures the past winter came to the front in the two papers: "An Unprecedented Period of Low Temperatures—Its Effect on the Chicago Water System, "by Loran D. Gayton, Acting City Engineer, Chicago, and "A Review of Thawing Service Pipes," by Frank C. Amsbary, Jr., Supt. Illinois Water Service Company, Champaign. These two papers fitted together nicely and the methods used for thawing services—hydrants and mains, especially in Chicago, were of much interest.

Seemingly every one who had troubles, added something to the discussion. Electric equipment for thawing services appeared to be held in high regard and seemed to be the most popular type of equipment.

Professor F. M. Dawson explained that the use of electricity for thawing frozen water pipes was originated at the University of Wisconsin in 1895 by Professor Jackson and Professor Miller solely as a stunt from laboratory experiments, but it worked.

At Winnetka, Mr. Stanley Knox explained that they drew water from their hot water circulating pond and mixed sufficient amounts with the cold lake water so that the temperature of the latter was raised to about 47°F. This procedure obviated any freezing diffi-

culties. This procedure was possible at Winnetka as the village has a municipal steam electric generating station.

Mr. John L. Ford pointed out that at Delphi, Indiana, meters were prevented from freezing by packing the curb vaults with straw.

The use of the steam jet was discussed by Mr. Gayton at the request of C. M. Roos who had not found this a satisfactory method.

Mr. Enslow described the use of heated air, wherein a coil of air pipe was heated in a large kettle and the air blown into the frozen pipe through a jet. Also that H_2SO_4 was used to thaw out hydrants in some places.

Mr. W. W. Brush spoke of using motor car exhaust as a source of heat for thawing and also explained that in Russia the water not only is warmed, but that the pipe lines are laid in insulating materials so that they do not come in contact with the frozen ground.

Mr. Trentlage stated that in Elgin gasoline was used to heat up the hydrant and thaw it out.

Who pays for the thawing was also an interesting question. When the water department did not do the work, thawing of services was generally paid for by the customer. With the private Companies, it seemed to be customary for them to stand the cost. The same was true in many municipalities where the work was done by city forces. In some instances, however, a charge was made for a second thawing.

The point was made that some difficulty was experienced with electrical thawing when certain jointing compounds were used.

Mr. Frank Broz reported that his troubles really started after the frost came out. It was not till then that the leaks began to show up.

Mr. Leon Smith, Superintendent of the Madison, Wisconsin, Water Works reported that they set up three electrical thawing units of the electrical welding type. These were manned by three crews each, nine all together, thus giving 24 hours service under all conditions. Their records showed that prompt service to the consumer was history of the Water Works activity for the first ten days of the cold weather.

Mr. W. R. Gelston, Jr., Chemist of the Quincy Water Commission reported their experiences with thawing as follows:

"The two preceding papers have so thoroughly covered the general practices in thawing that I feel there is little I can add except to mention the specific methods in use in Quincy during the past winter. This was a new problem to us as practically all freeze-ups in previous years had been on the property owners end of the piping. As a result we had no equipment of our own for such

work and had to depend on two electric welders of the 30–40 volt, 300 amp. type rented from two local firms."

"In thawing services, connections were made in two adjacent houses. In the case of mains and hydrant branches, connections were made to hydrants, and to valves by means of valve keys."

"A flat charge of $2.50 was made for thawing services regardless of the circumstances. On the average this means that the water works paid half of the cost and the customer the other half."

"We paid $2.00 per hour for one welder and operator. This machine was mounted on a water works two ton truck. The total cost of this outfit including $1.00 per hour for water works truck, drivers wages, gas, etc. was $262.00. This outfit thawed 51 services, or a cost of $5.14 per service. The same machine thawed one four-inch and one six-inch main in 18¾ hours at a cost of $55.64 for the two."

"The other machine with operator and mounted on a welding company truck cost $3.75 per hour. It thawed 47 services at a total cost of $236.00 or $5.02 per service."

Mr. Arthur H. Miller of the Sheboygan Water Works reported that out of 10,000 services they only had about 50 services and 75 meters frozen. He did say, however, they were all very anxious regarding the effect of an 18-inch thick ice cake on their 120-foot diameter surface reservoir. The concrete roof is supported on steel structural columns and they were fearful that these might be weakened. However, the ice simply slid up and down on them without doing any damage at all.

Session adjourned at 6:00 p.m.

The Annual Banquet was a most successful affair at the Georgian Hotel. The management reported 133 in attendance. Mr. and Mrs. Wesley W. Polk arranged a very entertaining program of instrumental, vocal and dancing numbers. Toastmaster William Lister, Corporation Council of Evanston put every one in a hilarious mood by his witty Scottish stories told in a Scottish brogue.

Saturday, April 11, 1936

Mr. Frank J. Broz, Superintendent of the Bureau of Water, Cicero, Ill. presented a paper entitled "Problems of the ordinary Superintendent," followed by an interesting discussion by Mr. McNicol, Manager of the Lake Forest Water Department.

Mr. L. R. Howson contributed the following in the way of discussions:

"I would particularly emphasize the part of the paper relating to the executive direction of municipal water works. I thoroughly concur in

Mr. Broz's suggestion, of the desirability of operations under a Water Works Commission so constituted as to maintain continuing personnel free from political influence. I have not observed that it is necessary or even desirable to have the Water Commission self-perpetuating. If the committee consists of five members, one to be appointed each year by the Mayor subject to the approval of the Council or City Commission, there is little likelihood of political control. It has the psychological advantage of not being inbred."

Mr. Enslow contributed a new one. He stated he had been advised that in Rensselaer, Indiana, the customer signs a contract permitting the City Treasurer to draw against his bank account for payment of his water bill.

Mr. H. L. Meites suggested that advantage be taken of the Lien Law for the collection of the delinquent water bill. Mr. S. T. Anderson stated that the Corporation Council of Springfield had advised him the Lien Law had been declared unconstitutional. Thereupon Mr. Meites suggested the Association sponsor a Lien Law that would prove constitutional and be workable for use in collecting water bills.

Mr. Oscar Gullans, Senior Chemist of the Chicago Water Experimental Filter Plant, described under the title "A Comparison of Odor Elimination" the experiments conducted and the technique employed in developing the so called *Threshold* Test for odors.

Discussion was followed by Mr. George B. Prindle, Supt. of the Highland Park Water Works and by Mr. Charles H. Spaulding, Supt. of the Department of Light, Water and Power, Springfield, Illinois.

At 11:55 a.m. Dr. A. M. Buswell, Chief of the State Water Survey and Professor of Chemistry, University of Illinois, presented his paper entitled, "Factors Affecting Corrosion in Natural Waters." This proved to be a live subject and the chemists went into action at once and proceeded to develop a round table debating society, leading parts being taken by Enslow, Baylis, Buswell, Behrman, and Babbs. It was 1:00 p.m. before the excitement was over.

Mr. A. P. Kuranz, Chairman of the Wisconsin Section of the American Water Works Association, extended a warm invitation to the Illinois members to attend the Wisconsin meeting in the fall.

This closed the formal program for the morning and Chairman Polk called the Business Session to order a few minutes after one o'clock.

The first report was that of the Secretary of the Section which

was ordered received and placed on file. The report of the Treasurer showed an income of $437.54 and total expenditures of $182.09 for the year with a cash balance on April 9 of $255.45. (This report together with the Treasurer's books and receipted vouchers had previously been furnished to the Auditing Committee.)

The Section Director Mr. W. R. Gelston, prepared a fine and detailed report of the activities of the Board of Directors of the National Society. Owing to illness, however, Mr. Gelston was unable to be present and the report was presented by Mr. W. R. Gelston, Jr. The report was ordered accepted and placed on file.

By this time it was 1:40 p.m. and upon motion the session recessed till 3:00 p.m. for lunch.

The Auditor's Report found the Treasurer's accounts in good order. Upon motion, the reports of the Treasurer and of the Auditing Committee were adopted.

The Report of the Committee on Scope and Policy, Charles H. Spaulding, Chairman, was ordered accepted and placed on file.

A report from the Membership Committee by W. D. Gerber, Chairman, consisting of a brief statement of the status of the Section Membership, was ordered accepted and placed on file.

The Legislative Committee had no report, but Professor H. E. Babbitt suggested that the committee for this year should follow closely legislative activities this winter and be prepared to sound the alarm against any legislation that would be harmful to water works management and water works operators.

The Committee on Water Works School had no report.

The Resolutions Committee presented various resolutions which were adopted.

Professor H. E. Babbitt, as Chairman of the Committee, having in charge the preparation of amendments to the By-Laws presented a very complete report embodying a complete set of By-Laws.

There was some discussion of various parts of the report. Most of the discussion was largely from a desire on the part of members to learn from the Committee the reason for the changes as proposed. In the end the following motion prevailed unanimously.

"That the By-Laws of the Illinois Section in the Report of the American Water Works Association be amended to read as proposed by the Committee on Revision of By-Laws, except that the word 'Ex-officio' be inserted after the words Past Chairman in Line 4, Section 1, Article V, and that the second paragraph in Section 4, Article V be omitted."

Under new business and in accordance with the suggestion made during the morning session by Mr. Meites relative to a properly developed Lien Law, Professor H. E. Babbitt presented the motion, duly seconded by Dr. A. M. Buswell, that the suggestion regarding a law permitting liens on property for the collection of water bills be referred to the Legislative Committee. Motion approved.

The Chairman announced that, in accordance with the wishes of the membership as expressed by the balloting, he declared the following persons elected to the respective offices for the ensuing year,

Chairman: Charles H. Spaulding
Vice Chairman: Frank C. Amsbary, Jr.
Trustees 1939: George B. Prindle
Secretary-Treasurer: Winfred D. Gerber
Section Director: Harold E. Babbitt

and that these persons together with the two hold-over Trustees Ray Crozier and Fred G. Gordon would constitute the membership of the Board of Trustees for the year 1936–37.

Chairman Polk then called upon the newly elected Chairman Mr. Charles H. Spaulding to take the chair and preside during the final session of the meeting.

"The Fairbury Water Softening Plant" by J. J. Woltman, Consulting Engineer, was an interesting description of the design of a water softening plant to treat a well water supply for a small city.

Mr. Herbert L. White, Sanitary Engineer for the University of Illinois, developed the construction of "Gravel Packed Wells" in an interesting way. The use of a small sized camera for photographing the conditions down in a well was especially worthy of note.

The discussion of this paper fell to the lot of W. D. Gerber, Engineer of the State Water Survey. As the time was passing the discussion was confined to a few statements that the construction of water wells is far from a satisfactory industry and that there is room for much study and research in the field. A suggestion was voiced that a definite program on well construction would be surprisingly interesting.

Mr. C. C. Ley, Superintendent of the Water and Light Department of Kenilworth closed the afternoon session with a most interesting description of "Sub-surface Filtration at Kenilworth." This paper was profusely illustrated with lantern views. The paper should be of

much value to those who must increase their filtration rate but who at the same time are restricted in building additional units.

The 28th Annual Meeting adjourned at 5:20 p.m. Saturday, April 11, 1936.

WINFRED D. GERBER,
Secretary-Treasurer.

ABSTRACTS OF WATER WORKS LITERATURE

Frank Hannan

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the journal.

Progress in Water Supply and Treatment during 1935. Lewis V. Carpenter Water Works and Sewerage, 83: 1, 1–8, January 1936. Résumé of progress. Trends in treatment and supply are discussed. Topics touched on are:—elevated storage and beautification; pipe, pipe lining, pipe depreciation; main cleaning; National Water Planning; air conditioning and water consumption; design of Milwaukee filtration plant; operation of Burnt Mills plant; anthracite as a filter medium; methods of filter washing; coagulants; taste and odor control; corrosion control; gadgets and kinks; operator licensing; and water works short schools.—*H. E. Hudson, Jr.*

A Study of Filtering Materials of Rapid Sand Filters. Part 7: Specifications for Filtering Materials. John R. Baylis. Water Works and Sewerage, 83: 1, 20–23, January, 1936. Article summarizes those findings from writer's previous papers which bear on filter material specifications. Improved method for determining sand size and uniformity coefficient is discussed. Typical specifications for filtering material are given. These include grading and composition of gravel, method of determining size of gravel, composition of sand, size and grading of sand, combination of sands to produce desired grading, depth of sand, and procedure for determining effective size and uniformity coefficient of sand. Specifications are written for 24-inch sand bed, but it is explained how other depths may be used. If crushed material is to be purchased, effect of porosity on resistance to filtration should be considered in setting effective size. Effect of poor stratification according to size, caused by non-homogeneity of material, is briefly discussed.—*H. E. Hudson, Jr.*

Fifth Corrosion Congress at Berlin. Chemiker-Zeitung, 59: 924 and 986, 1935. From Water Pollution Research Summary, 9: 3, 80. March 1936. **The Destructive Action of Cold Water on Metals.** F. Tödt. Iron dissolves in cold quiescent water of pH 4–11 at rate of about 3 grams per square meter per day, due to galvanic action at iron-water interface. Progress of corrosion generally depends on atmospheric oxygen, which combines with cathodic hydrogen. Corrosion may be reduced by removing oxygen, by painting, by protective layers deposited from water naturally, or by chemicals added, e.g. phosphates. **Corrosion of Metallic Materials in Water Works.** G. Wiegand. Destruction of metals used in collecting ground water is chiefly caused by hydrogen sulphide; while in filters, it is due mainly to carbon dioxide and

oxygen. Cast iron and steel may be damaged by high sulphur content of soil; coverings of jute and asphalt sometimes fail, owing to brittleness of asphalt; bitumen is preferable. Stray electric currents may cause corrosion. **Corrosion Damages by Industrial Waste Waters and Their Prevention.** H. STOOF. Discusses corrosion with reference to experience in treatment of wastes, and protection of materials used. **Influence of Continuous and Intermittent Wetting by Sea Water on the Corrosion of Steel.** F. EISENSTECKEN. Describes laboratory experiments with artificial sea water upon steel and coppered steel. **The Structure of Cast Iron and Its Relation to the Corrosion Problem.** E. PIWOWARSKY. Discusses the properties of grey cast iron. **Corrosion and the Formation of Protective Layers in Cold Water Supply Systems of Cast Iron.** L. W. HAASE. Under optimum conditions of alkalinity and oxygen content, natural protective layer rapidly forms on cast iron pipe; skin on iron generally accelerates formation of this layer. It is practically impossible to prepare water suitable for all pipe materials. **Recent Experiences in the De-acidification of Tap Water.** NAUMANN. Aëration to remove carbon dioxide for hard waters, marble filtration for soft waters with high carbon dioxide, and chemicals, e.g., sodium carbonate, sodium hydroxide, or lime, render water capable of depositing protective layer. Process recently tested is filtration through "magno-masse" which is partially calcined dolomite; it removes acidity, iron, and manganese. **Under Water Protection in Sea Water.** C. BÄRENFÄNGER. Describes experiments made with copper-bearing steel (from 0.25 to 1.0 per-cent copper).—*W. G. Carey.*

Direction and Administration of German Water Works. S. CLODIUS. Gas- und Wasserfach, **78:** 365, 1935. From Water Pollution Research Summary, **9:** 1, 4, January 1936. Most communities with less than 2,000 inhabitants are without centralised water supply. Water works are owned mainly by public companies; capital invested runs to 2.5 thousand million marks.

Importance of good water supply is stressed; diagrams are given illustrating classical cholera epidemic in Hamburg and Altona in 1892–93, and decrease in typhoid deaths from 1875 to 1932. New regulations have been suggested and new laws are being prepared which will introduce fundamental changes. Per capita consumption in towns having many industries is compared with that in towns having but few. Long-distance water supplies have not been generally necessary, but Harz-Bremen pipe line (200 kilometers) is mentioned and instances are given of long-distance supplies in the United States, England, and France.—*W. G. Carey.*

The Water Supply of Hamburg. J. BOWMAN. Water and Water Engineering, **37:** 450, 333–337, July 1935. Illustrated account of Hamburg's water system. After destruction of works by fire in 1842, new supply from Elbe was used; slow sand filtration plant constructed in 1895, which is still in use, is described. Since 1923, chlorine has been applied to water leaving settling reservoirs. In 1895, Billbrook water works was constructed, which supplies 9 million gallons daily, or one-fifth of total requirements; 60 per cent of this is from artesian wells. Water has hardness of 12.1 degrees (German) and iron is removed by aëration and double filtration. In 1910–1914, other borings

were made, and in 1928, Curslack works, supplying 30 million gallons per day, were completed. These works are line of boreholes on strip of ground 100 yards wide and 5 miles long. On both sides of strip are open channels to irrigate land north and south of strip with water from Elbe, Bille, and Brookwettern. Water from bores is pumped to aërating and sand catching chambers, then to 24 upper and 24 lower filters, which filter at 11 feet and 17 feet per hour, respectively.—*W. G. Carey.*

The Problem of the Formation of Protective Layers on Copper. L. W. Haase. Zeitschrift für Metallkunde, **26**: 185, 1934. Discusses formation of protective layer of cuprous oxide on copper and distinguishes it from natural and artificial patinas. Patinas contain basic copper compounds, carbonate and sulfate and small amounts of nitrate and chloride, form only incomplete coverings, exert no polarising action, and are therefore chemically and electro-chemically non-protective. For waters of equal oxygen content, patina is lighter in color for harder water. Patinas rarely form unless oxygen and hardness present; if hardness only, patina readily scales off; but if water contains oxygen also, layer of cuprous oxide forms below patina and metal is protected against corrosion. Importance of maintaining conditions necessary for oxide formation in copper pipes is stressed.—*W. G. Carey.*

Practical Applications of Oligodynamic Action. W. Raadsveld. Chemisch Weekblad, **31**: 505, 1934. Methods for utilization of copper sulphate for algae control and of copper sulphate and silver salts in conjunction with chlorination are discussed. Treatment of swimming pool water at Hague by aluminum sulfate, and disinfection with copper sulfate and bleaching powder are described. In brewing and paper making, copper pipes, or treatment of water with copper filings, would be advantageous for controlling algae. Use of porous filters and of beads impregnated with active silver or other metals, Krause's Katadyn process, and Electro-Katadyn process (electric current between silver electrodes) for continuous sterilization of water are described. Data on use of Electro-Katadyn process at small water supply at Heidelberg, at ice factory, at brewery, and at Frankfurt swimming pool are given. Effect of colloidal organic matter on process and permissible amounts of silver and copper ions in water supplies are dealt with.—*W. G. Carey.*

Determination of Lead in Potable Waters. J. F. Reith and J. de Beus. Zeitschrift für analytische Chemie, **103**: 13–27, 1935. Any deposit which may contain lead is first dissolved by addition of 5 cc. per litre of water of 4 *N* hydrochloric acid, acting for 15 minutes. In colorless waters containing less than 10 p.p.m. iron, 80 cc. are treated with 4 drops 10 percent potassium cyanide, 10 cc. 20 percent Rochelle salt, and 10 cc. 20 percent ammonium chloride in 2 *N* ammonia. Color (if any) is matched against lead standards treated with same reagents and is subtracted from final reading. Sample is then treated with 2 drops fresh sodium sulphide (10 gms. dissolved in 25 cc. water and made up to 100 cc. with glycerin) and matched against fresh standards. Sulphide solution should give no thiosulphate opalescence after 15 minutes treatment of 10 drops with a few cc. of 5 *N* acetic acid. Determination should not take more than 10 minutes, after which bleaching occurs. In

waters with yellow tinge due to organic matter, and with more than 10 p.p.m. iron, 100 cc. water is treated with 5 cc. of 5 percent ammonium persulfate, water evaporated to 50 cc., treated with 4 drops cyanide and 10 cc. Rochelle solution. If clear, 10 cc. ammonium chloride are added and solution tested in Nessler cylinder as before. If not clear, liquid is filtered, made up to 90 cc., and then treated with ammonium chloride and tested. Enrichment by adsorption on calcium carbonate is suitable for all waters, including highly ferruginous. One litre of water (or amount containing 0.1 milligram lead) is treated with 5 cc. cyanide and made faintly alkaline to phenolphthalein. One-half gram precipitated calcium carbonate is added, with occasional agitation for one hour, and after 3 or 4 hours settling, solution is filtered through Buchner funnel. Deposit is washed with alkaline water (sodium bicarbonate), dissolved in boiling hydrochloric acid (5 cc. 4 *N* hydrochloric acid in 40 cc. water) and diluted to 150 cc. Solution is oxidised as above with persulfate, concentrated to 90 cc. and boiled down to 80 cc. with 0.1 gram hydrazine hydrochloride to reduce ferric iron. Lead is then determined as above. As a check, 10 cc. 4 *N* hydrochloric acid are added after comparison; color due to lead disappears after few moments, any color due to mercury, copper, or bismuth remains.—*W. G. Carey.*

Ensuring the Water Supply of Greater Berlin by Impounding Reservoirs. E. MATTERN. Wasser und Abwasser, 33: 97, 1935. Berlin is supplied chiefly with ground water; the consumption in 1934 was 200 million cubic meters (53 thousand million U. S. gallons), which will be doubled for population of 10 millions. Since middle of last century, ground water level around Berlin has fallen several meters. Possibility is discussed of constructing impounding reservoirs in upper reaches of rivers Spree or Havel, where 110 and 140 million cubic meters, respectively, of storage capacity are available. Cost of constructing reservoirs is estimated at 40.1 million marks.—*W. G. Carey.*

Modification of Minkewitsch's Milk Culture Medium for the Colorimetry of Water. F. BRANCATO. Ann. igiene, 44: 1, 12–20, 1934; Chimie et industrie, 32: 327. From Chem. Abst., 28: 6759, November 10, 1934. Medium has been modified to obtain simultaneously: (1) more certain proof of presence of *Es. coli* by observing, not only coagulation (which is considered by some as non-specific), but also fermentation of glucose, etc., and (2) some idea of source of strains of *Es. coli* by determining acidity. Boil 200 cc. milk 5 minutes, filter through gauze, add 400 cc. 15 per cent peptone solution, adjust pH to 7.4, and filter. Numeration of *Es. coli* is carried out in presence of indicator consisting of 1 per cent rosolic acid in 1 per cent sodium carbonate; 2 per cent of this solution is added to each tube. While production of acid is generally shown by coagulation, it has been observed that, at 46° certain strains can decolorize rosolic acid but do not produce sufficient acid to cause coagulation. On this medium, other bacteria do not interfere with development of *Es. coli.*—*R. E. Thompson.*

The Application of Activated Carbon for Water Purification in Breweries, Ice Factories, etc. BRUNO MÜLLER. Apparatebau, 46: 109–10, 1934. From Chem. Abst., 28: 6885, November 10, 1934. Installation is described for re-

moval of oil from water in which activated carbon, 1.5–3 millimeters size, is packed 1 meter high in tower between 2 sieves. Hot condensate flowing at several millimeters per second enters at bottom and leaves at top with little pressure drop. Capacities are up to 30,000 cubic meters per day. Hydraffin is 50 or more times as active as charcoal or bone black; it may absorb 15 per cent of its weight of oil before regeneration by reverse flushing, steaming, or chemical treatment, is required. Recent use of activated carbon is in removal of excess chlorine.—*R. E. Thompson.*

Chlorination of Condenser Water. DON J. NEMETH. Combustion, 6: 1, 16–21, 1934. From Chem. Abst., 28: 6887, November 10, 1934. Review and discussion of inhibition of algal and slime growths in circulating water by chlorination.—*R. E. Thompson.*

Quality of the Waters of Southeastern Nevada Drainage Basins and Water Resources. GEO. HARDMAN and MERIDITH R. MILLER. Univ. Nev. Agr. Expt. Sta., Bull. 136: 62 pp., 1934. From Chem. Abst., 28: 6883, November 10, 1934. Irrigation waters containing alkali coefficient greater than 18 are considered of good quality; from 18 to 6, fair; 6 to 1.2, poor; and less than 1.2, bad. Alkali coefficient, k, is obtained from chemical analysis by means of formulas: $k = 662/(\text{Na} - 0.32\ \text{Cl} - 0.43\ \text{sulfate})$ if $\text{Na} - 0.65\ \text{Cl} - 0.48$ sulfate is positive. If $\text{Na} - 0.65$ Cl is positive, but not greater than 0.48 sulfate, then $k - 6620/(\text{Na} + 2.6\ \text{Cl})$. If $\text{Na} - 0.65$ Cl is zero, or negative, then $k = 2040/\text{Cl}$. Waters for domestic use are classified as good, or very good, if total solids do not exceed 500 p.p.m., and water is clear, odorless, tasteless, and free from organic matter. Quality is fair, if total solids range from 500 to 1000 p.p.m. Sodium sulfate, sodium bicarbonate, and calcium bicarbonate waters are considered in this class. Poor drinking waters contain from 1000 to 5000 p.p.m. total solids, owing to presence of much sodium and calcium. Unfit waters contain over 5000 p.p.m. solids. Waters of high mineral content have been used for years by local residents with no apparent ill effects.—*R. E. Thompson.*

Step-Photometric Microchemical Analysis of Drinking and Service Waters. X. Determination of Sulfate. CARL URBACH. Mikrochemie, 14: 321–30, 1934; cf. C. A. 28: 3153. From Chem Abst., 28: 6886, November 10, 1934. Method depends upon treating water with excess barium chromate. If sulfate is present, less soluble barium sulfate is formed and equivalent amount of CrO_4^{--} passes into solution and can be determined colorimetrically by reaction with diphenylcarbazide. Full data given for carrying out method with photometer. **XI. Determination of Lead.** Ibid., 331–40. Typical color curves and 2 long tables for converting drum readings into percentages of lead are given for color that develops when water containing lead in very small quantities is treated with sodium sulfide solution—*R. E. Thompson.*

The Manganese-Removal Plants at the Kaulsdorf and Wuhlheide Plants of the Berlin Municipal Waterworks. SWYTER. Gas- u. Wasserfach, 77: 553–6, 572–9, 1934. From Chem. Abst., 28: 6887, November 10, 1934. At Kaulsdorf, water is first neutralized with milk of lime and then aërated in special pressure

"oxidizer" filled with calcium carbonate, excess air and any hydrogen sulfide and carbon dioxide escaping at top of tower. Water then passes down through special 2-section filter, upper half of which contains 1.5-meter layer of 3-millimeter sand to remove iron. Lower half, containing 1.2-meter layer of 1 to 3-millimeter sand, "worked in," is used to remove manganese, special care being taken during backwashing to avoid disturbing active manganese dioxide layer. Manganese content is reduced from 0.24 p.p.m. to zero. At Wuhlheide, appearance of manganese in factories and homes led to use of special filter system, which is described. Corrosion difficulties in system supplying air for backwashing led to use of Eternit pipes. Water is rather high in free carbon dioxide.—*R. E. Thompson.*

Unsuspected Copper in Domestic Water Supplies. David W. Horn. Am. J. Pharm., 106: 262–3, 1934. From Chem. Abst., 28: 6887, November 10, 1934. Two domestic water systems consisting of joint air and water pump that maintains sufficient air pressure over water to force it through piping system, which is of copper, were found to contain copper in excess of Treasury Department standard (0.2 p.p.m.). Unless standard is too stringent, it would be unwise to use unguardedly this combination of air-water pump and copper piping.—*R. E. Thompson.*

The Water Problems of Apartment Buildings. D. K. French. Bldgs. & Bldg. Management, 34: 70–3, 1934. From Chem. Abst., 28: 6887, November 10, 1934. As chief use of water is for heating, most of problems are due to soluble gasses of corrosive nature. Buffered acids are successfully used to remove scale in heating coils.—*R. E. Thompson.*

The Solution of Oxygen from Air Bubbles. W. D. Scouller and W. Watson. Surveyor, 86: 15–16, 1934. From Chem. Abst. 28: 6888, November 10, 1934. Statements of Adeney that solution of oxygen from air bubbles can only be very minute (C. A. 27: 154) are refuted. Average oxygen dissolved from bubbles is 3.5 percent per foot rise. Oxygen absorbed per square meter bubble surface per 24 hours is 3 times amount absorbed through exposed surface.—*R. E. Thompson.*

The Winkler Test for Determining Oxygen in Boiler Feed Water. J. D. Yoder and A. C. Dresher. Combustion 5, No. 10, 18–22, 1934. From Chem. Absts. 28: 6889, November 10, 1934. Accuracy of Winkler test and sources of errors have been carefully studied. Oxygen in boiler feed water can be determined with accuracy of 0.01 cc. per liter in field determination if proper grade of soluble starch is used, sample is tested at temperature of 85°F., or less, correction is made for oxygen in reagents, all interfering substances are avoided, and proper precautions taken in drawing samples and making tests.—*R. E. Thompson.*

The Winkler Oxygen Method. Thomas J. Finnegan and Richard C. Corey. Combustion, 5: 12, 31–3, 1934. From Chem. Abst. 28: 6890, November 10, 1934. Discussion of articles by Alfano (C. A. 28: 3687) and Yoder and Dresher (cf. preceding abstract).—*R. E. Thompson.*

Determining the True pH Value. D. S. CLARK. Combustion, **6**: 2, 30-1, 1934. From Chem. Abst., **28**: 6889, November 10, 1934. Previous discussions of boiler-water pH determinations are reviewed and electrical-resistance method is recommended.—*R. E. Thompson.*

The Determination of Hydrogen Sulfide in Water. A. HEMMELER. Industria chimica, **9**: 894-8, 1934. From Chem. Abst. **28**: 6886, November 10, 1934. Hydrogen sulfide can be determined by adding known amount of cadmium salt and when precipitated cadmium sulfide has settled, adding standard iodine and determining excess. Reaction is $CdS + I_2 = CdI_2 + S$.—*R. E. Thompson.*

Deposits and Corrosion in the Cooling System of Internal Combustion Engines. E. A. SMITH. J. Inst. Automobile Engrs. (London), **2**: 8, 29-59, 1934. From Chem. Abst., **28**: 6890, November 10, 1934. Individual characteristics of each of chief salts producing deposits or corrosion, and remedial measures are discussed. Common methods of scale prevention, including use of sodium aluminate, sodium carbonate, and sodium phosphates, are discussed. In experiments with natural compounds, all colloids, mixed results were obtained. While presence or absence of colloid exerted no noticeable influence upon reaction times between sodium base and calcium salts, settling times of precipitated calcium salts in former case were much greater: flocculation was completely hindered in case of phosphate precipitates which occured as fine suspensions. Ultimate deposits in various experiments using colloids differed widely; from fine, non-cohering silt to slimy sand. Most satisfactory compounds used were starch and quebracho. Importance of using best commercial soluble starch is emphasized. Table is given of proportion of various constituents recommended for different conditions of hardness. Application of method in practice is detailed.—*R. E. Thompson.*

Natural Silicates: Their Deposition as Objectionable Formation Within Boilers. CYRUS WM. RICE. Combustion, **5**: 12, 16-21, 1934. From Chem. Abst., **28**: 6890, November 10, 1934. Formation of silica deposits is discussed. Percentage of silica in total precipitating solids appears to be best measure of silica scale-producing qualities. Prevention of hard silica deposits is of far greater consequence than prevention of sulfate deposits. Phosphates have proved most effective in reducing silica deposits; but they do not prevent formation of hard silica scale when soluble silicates accumulate and aluminum in some form is also present.—*R. E. Thompson.*

Lubricating Oil and Steam-Boiler Corrosion. F. HANAMAN. Arhiv. Hem. Farm., **8**: 50-3 (in German 53), 1934. From Chem. Abst., **28**: 6890, November 10, 1934. Injurious results from accumulation of lubricating oils in boiler slime and their mechanism are described. Presence of oil in fresh slime can be detected microscopically.—*R. E. Thompson.*

Recent Developments in Lead Pipe for Water Services. W. SINGLETON. Surveyor, **85**: 364, 1934. From Chem. Abst., **28**: 6890, November 10, 1934.

Tellurium added to lead in concentration of 0.05 per cent gives product with 2 remarkable properties: (1) tensile strength after strain is nearly doubled; and (2) grain is extra fine and uniform. Value of product is emphasized by results of hydraulic, bursting, freezing, and fatigue tests.—*R. E. Thompson.*

Influence of the Chemical Composition of Water on Various Piping Materials. R. GIRARD. Eau, 27: 40, 1934; cf. C. A., 27: 5850. From Chem. Abst., 28: 6891, November 10, 1934. Speed of corrosion reaction of acid water is result of 2 forces, solution and precipitation. First is proportional to H-ion concentration and second, to square of concentration of calcium ions. Soft water is most corrosive. Condition can be improved by passing water over broken marble rubble. Contact of 20–30 minutes is usually sufficient.—*R. E. Thompson.*

Anthracite as a Filter Medium. H. G. TURNER and G. S. SCOTT. Combustion, 5: 11, 23–7, 1934; cf. C. A., 28: 3815. From Chem. Abst., 28: 6891, November 10, 1934. Hot alkaline waters will dissolve silica from siliceous filter materials and deposit silica as hard scale in boiler using filtered water. This solution occurs indefinitely, at fairly rapid rate, with sand; but only for short period and at low rate when anthracite is used as filter medium. Other properties of anthracite indicate that its use as filter medium is not only possible, but efficient and economical as well.—*R. E. Thompson.*

Step-Photometric Microanalysis of Drinking and Service Water. XII. Iron Determination. CARL URBACH. Mikrochemie, 15: 207–26, 1934. From Chem. Abst., 29: 260, January 10, 1935. Determination of iron described, including very comprehensive table of all necessary data.—*R. E. Thompson.*

A Case of Contamination of a Water-Bearing Stratum by Seepage of Chemicals. G. GRENOILLEAU. Tech. sanit. munic., 29: 180–1, 1934. From Chem. Abst., 28: 6895, November 10, 1934. Copper sulfate from wood-impregnation plant leached into village ground water supply. It was detected by formation of bluish-colored deposit when soap was added to water. Water contained from 6 to 9 p.p.m.; before contamination, amount did not exceed 2 p.p.m. While not dangerous to health, presence of copper in water was considered undesirable.—*R. E. Thompson.*

An Investigation of the Bacterial Pollution of Waters of Port Philip Bay, Melbourne. NANCY ATKINSON. Proc. Roy. Soc. Victoria, (N. S.), 46: 1–19, 1933. From Chem. Abst., 28: 6895, November 10, 1934. Almost complete correlation of citrate and methyl red tests were obtained, suggesting possibility of citrate test alone as confirmatory test for *Es. coli*, using citrate-agar cultures incubated for 24 hours. Indole test did not agree very well with other 2 tests.—*R. E. Thompson.*

Heat of Hydration of Cements for Boulder Dam. THOMAS J. NOLAND, JR. Civil Eng., 4: 365–7, 1934. From Chem. Abst., 28: 6970, November 10, 1934. Details given of adiabetic, high insulation, and heat-of-solution methods of

determining heat of hydration of cement. Latter method requires only 1 or 2 hours and takes into account initial heat of hydration. Greater fineness of cement and increased water-cement ratios raise heat of hydration at early ages. About 28 days after pouring, 90 percent of total heat has developed. Cements showing high strength in proportion to heat of hydration are low in tricalcium aluminate.—*R. E. Thompson.*

The Oxidation of Gas Works Liquors in Admixture with Sewage. A. Key and W. Etheridge. Surveyor, **86**: 29–30, 1934. From Chem. Abst., **28**: 6894. November 10, 1934. Phenol was completely and rapidly oxidized by activated sludge. Catechol was less easy to treat, but 100 per cent oxidation was obtained in 24 hours.—*R. E. Thompson.*

Titration of Dyes for Their Bacteriostatic Action. Mary V. Reed and Elizabeth F. Genung. Stain Tech., **9**: 117–28, 1934; cf. C. A., **28**: 2384. From Chem. Abst., **28**: 7288, November 20, 1934. Study was made of extrinsic bacteriostatic value of different lots of 2 brands of several triphenylmethane dyes. Different lots of the 2 dyes possess practically same bacteriostatic value. Et group in brilliant green is responsible for marked inhibition of colon organisms. Bacteriostatic action of a dye is influenced by pH, constituents of medium, and amount of inoculum.—*R. E. Thompson.*

Influence of Temperature on Coagulation. Clarence J. Velz. Civil Eng., **4**: 345–9, 1934. From Chem. Abst., **28**: 7386, November 20, 1934. Amount of coagulant needed to produce standard water depends upon temperature. Table shows alum doses required at 14–24°. Series of cooling experiments confirms mathematical calculation that temperature is dominant factor. Table gives operating data for 5 days of 35 m.g.d. plant showing color, pH, temperature, and alum dose. Difference between mathematical coefficient of relationship indicates that color influence is about twice as strong as pH, but that neither is significant. Effects of high temperature can be eliminated by adjusting pH to optimum point. At 8–14°, excellent results can be obtained at pH 6.7, but at 20–25° it is necessary to adjust pH to point below 5.8. Chemical composition of water had little effect in floc formation or color removal. Temperature influence fits logically into electrochemical concept.—*R. E. Thompson.*

Water Analysis. I. Titrimetric Determination of Sulfate Ions. E. Hansen-Schmidt. Arch. Hyg. Bakt., **112**: 63–9, 1934. From Chem. Abst., **28**: 7387, November 20, 1934. Sulfate methods of Köszegi and of Schmidt compare favorably with gravimetric methods and are much more rapid for water analysis. These methods are recommended for waters containing not more than 500 p.p.m. sulfate. Nomogram is given for calculating hardness from sulfate content.—*R. E. Thompson.*

Colorimetric Method for Determination of Sulfuric Acid in Drinking Waters. D. B. Iokhel'son. Ukraïn. Khem. Zhur., **9**: Wiss. Teil 25–8, 1934 (in Russian). From Chem. Abst. **28**: 7387, November 20, 1934. Water to be analyzed (5–10

cc.) is introduced into centrifuge tube and acidified with 2 or 3 drops glacial acetic acid. After mixing, 2 or 3 cc. 95 percent alcohol is added, followed by 1 cc. of 1 percent lead nitrate, drop by drop. Precipitate of lead sulfate is centrifuged and washed 2 or 3 times with 5-cc. portions of 30 percent alcohol, until lead nitrate is removed. This can be ascertained by adding to washings 2 or 3 drops of 10 percent sodium sulfide, prepared by dissolving 5 grams chemically pure sodium sulfide in 25 cc. of water and 25 cc. chemically pure glycerol. Precipitate is dissolved in 10 cc. of 0.5 percent sodium hydroxide, transferred to HEHNER cylinder and after solution has been diluted almost to mark, 1 cc. 10 percent sodium sulfide is introduced and contents shaken. To another cylinder are introduced: 1 cc. standard solution of lead nitrate (0.8275 gram chemically pure lead nitrate dried at 120° and dissolved in 1 liter of water; 0.1 cc. = 0.2 milligram SO_3), 10 cc. 0.5 percent sodium hydroxide, water almost to mark, and 1 cc. sodium sulfide. Contents are brought to mark, shaken, and brown-yellowish color of standard is compared with sample. Adjustment of colors is made by pouring into graduated cylinder the solution from tube with deeper color until colors match.—*R. E. Thompson.*

Effect of Pressure on Lead Water Pipe. HEINZ BABLIK and JOSEF KRYSTOF. Gas- u. Wasserfach, **77**: 625–8, 1934. From Chem. Abst., **28**: 7388, November 20, 1934. Water pipes are subjected to sudden pressure increases due to water hammer in addition to normal static pressure, and sum of these must be considered in testing lead pipe. It is suggested that limiting pressure for such pipes be taken as that which will cause 0.2 percent expansion in inner fibers. Economic limit of increasing thickness of pipe wall is given as (wall thickness)/(internal diameter) = 0.6. Resistance to internal pressure can be increased by alloying and by heat treatment.—*R. E. Thompson.*

Isolation of Enteric Bacilli from Sewage and Water and Its Bearing on Epidemiology. W. JAMES WILSON. Brit. Med. J., 1933, II, 560–2. From Chem. Abst., 28: 7390, November 20, 1934. By use of special medium and definite procedures, author was able to isolate typhoid bacilli from water when ratio of *Es. coli* to *Eberthella typhosi* was as low as 30 to 1. Enteric bacilli are present in considerable numbers in sewage. To make medium, dissolve 6 grams bismuth ammonio-citrate scales in 50 cc. boiling distilled water; neutralize with 2 cc. 10 percent sodium hydroxide; mix with solution obtained by boiling 20 grams sodium sulfite (anhydrous) in 100 cc. water; and add, while still boiling, 10 grams anhydrous trisodium phosphate. To sulfite-bismuth phosphate mixture when cool, add solution of glucose obtained by dissolving 10 grams commercial glucose in 50 cc. boiling distilled water. For preparation of old standard medium, add to 100 cc. of hot melted 3 percent nutrient agar 20 cc. of stock mixture, then 1 cc. 8 percent ferrous sulfate, and 0.5 cc. 1 percent brilliant green in distilled water; pour into Petri dishes and, when set, inoculate surface. Isolated colonies of *Eb. typhosi* and *Salmonella paratyphosi* are black, typhoid colonies usually appearing within 24 hours, paratyphoid within 48 hours. For direct plating, procedure is to add to 100 cc. 3 percent nutrient agar 10 cc. stock glucose-phosphate-sulfite-bismuth mixture, and 1 cc. 1 percent brilliant green. Equal volumes of medium, cooled to 55°, and water are then mixed and poured into Petri dishes.—*R. E. Thompson.*

The Determination of Phenol in Water and Sewage. F. Meinck and M. Horn. Angew. Chem., **47**: 625–8, 1934. From Chem. Abst., **28**: 7389, November 20, 1934. Inaccuracies of bromination and colorimetric methods are discussed and it is concluded that statement of results in p.p.m. is not justified. Proposed to use "volatility number" and "total phenol value" as approximate values, not expressed as p.p.m., but determined according to method indicated. 22 references.—*R. E. Thompson.*

Boiler Feed Water Treatment. S. D. Scorer. Colliery Eng., **11**: 90–1, 1934. From Chem. Abst., **28**: 7388, November 20, 1934. Calcium sulfate produces hard tenacious scale and appears to impart its qualities to other scales. If present in large amounts, silica assists in forming hard scale. Table of scale analyses and curve showing increase in fuel consumption given. Pitting is due to auto-corrosion caused by structural defects, or to strain in metal. Methods of softening discussed.—*R. E. Thompson.*

The Use of Anthracite for Filter Purposes. H. G. Turner. Proc. 3rd. Penna. Mineral Industries Conf., Coal Section, Penna. State Coll., Mineral Industries Expt. Sta., Bull. **15**: 29–32, 1934. From Chem. Abst., **28**: 7387, November 20, 1934. General Anthrafilt removes 93 per cent of turbid matter; sand 81 percent.—*R. E. Thompson.*

A New Vessel for Collecting and Transporting Samples of Water and Other Liquids for Bacteriological Investigation. Heinrich Thiele. Arch. Hyg. Bakt., **112**: 260–2, 1934. From Chem. Abst., **28**: 7387, November 20, 1934. Flask has special stopper which prevents contamination.—*R. E. Thompson.*

Copper and Its Oxidic Protective Coating. L. W. Haase. Chem. Fabrik., **1934**: 329–30. From Chem. Abst., **28**: 7231, November 20, 1934. Discussion, with 8 references, of conditions of formation of coating which consists of mixture of cuprous oxide and copper and is about 0.0025–0.0035 millimeter thick. Aluminum has similar coating.—*R. E. Thompson.*

The Watlington Water Works of Bermuda. W. D. Turner. Chemistry and Industry, **1934**: 819–23. From Chem. Abst., **29**: 259, January 10, 1935. Geology of region, softening plant, and distribution system described. Lime and sodium aluminate treatment is used, producing water containing 40–42 p.p.m. residual hardness, 80 p.p.m. sodium chloride, and free from *Es. coli.* Asbestos pipe is used in distribution system.—*R. E. Thompson.*

Chemical Analysis System Employing Photosensitive Devices. Charles A. Styer (to Westinghouse Elec. and Manfg. Co.). U. S. 1,977,359, October 16. From Chem. Abst., **29**: 82, January 10, 1935. In analyzing water for chlorine, reagent such as *o*-tolidine is added which produces yellowish green color by reaction with chlorine and serves to modify light-transmitting properties which may be used for analytical determinations, or for automatic regulation of chlorine added to water containing organic matter. Other determinations

may also be made. Details of apparatus and operation described.—*R. E. Thompson.*

Determination of Escherichia Coli with the Aid of Membrane Filters. K. BARSOV and A. SOCHILOVA. Mikrobiologiya, 2: 292–5, 1933. From Chem. Abst., 29: 193, January 10, 1935. If it is desired to test for *Es. coli* in relatively large volume of water, e.g., 100 cc., bacteria are first concentrated by filtering through nitrocellulose filter (pore diameter 1–2μ), which is then placed on special Endo medium in Petri dish, in such manner that surface of filter containing bacteria is upwards. Joined in this way, filter and medium are incubated 24 hours at 37°. Sufficient nutrient material from Petri dish passes upward through pores of filter to bring about typical colony formation on membrane. To check growth of saprophytes and to allow development of all strains of *Es. coli*, including *paracoli* (Gilbert), usual Endo medium is modified by adding 0.1 percent phenol and substituting glucose for lactose. —*R. E. Thompson.*

Boron Content of Natural Waters. N. V. TAGEEVA, S. G. TZEÏTLIN and A. I. MOROZOVA. Compt. rend. acad. sci. U. R. S. S. 3: 360–4 (in German 365–6), 1934. From Chem. Abst., 29: 261, January 10, 1935. FOOTE's method was employed. Salt water contained 0.01–0.06 per cent B_2O_3 as percentage of mineral residue; petroleum-bearing water, 0.01–0.6; hot-spring waters, 0.09–0.1. Water from volcanic mud contained 0.06–4 percent. It is suggested that boron is characteristic element, typical of petroleum-bearing waters and closely connected with geochemical history of oil.—*R. E. Thompson.*

Data on Meter Rates, Meter Installations, and Water Consumption for Ohio Municipalities, 1933–1934. Division of Sanitary Engineering, Ohio Dept. of Health. 19 pp. All Ohio municipalities having public water supplies were asked to submit data on meter rates and water consumption, supposedly for the year 1934; but some of the data are for 1933. Replies with the information desired totalled 308; data from 267 of which are included in the tabulations. It is noted that the average rates for water, when consumption is over 25,000 gallons per month, do not vary greatly, regardless of size of the municipality. In general, lower water rates may be expected in larger municipalities than in smaller ones. Where metering is more complete, the per capita water consumption increases with the population. Generally speaking, however, it is found that per capita consumption is less where percentage of metered services is large.—*G. C. Houser.*

Mine-Sealing Progress Shown in the Streams. Ohio Health News, 11: 7, 2, April 1, 1935. The abandoned-coal-mine sealing project in southeastern Ohio has been in progress for about 14 months. On March 1, 1935, 3548 of these abandoned openings had been closed, at a total cost of $111,802. Of this amount, $93,819 has been expended for labor, $8,471 for materials, tools and equipment, and $9,512 for supervision. Total acidity of the drainage from some mines which have been completely sealed for 6 to 9 months has decreased

by from 35 to 60 percent, while "total phenolphthalein iron content" has been lessened by 30 percent. There are thousands of abandoned mine openings in southeastern Ohio remaining to be sealed.—*G. C. Houser.*

Severe Lesson Taught by Ohio's Driest Year. Ohio Health News, 11: 7, 3, April 1, 1935. The year 1934 has the distinction of being the driest in the last 52, not excepting 1930. The drought really began in October 1933, and with 2 exceptions, August and September 1934, continued through 17 months; i.e., through February 1935. A number of water works reservoirs are still insufficiently filled to furnish reserve supply for coming summer. Deficient rainfall of past 5 years has caused decreasing supplies from wells and this effect is likely to be felt for some considerable time to come. After 1930 drought, it was thought that such a drought could not occur again for a long time; but the 1934 drought disproves this.—*G. C. Houser.*

Water Softening for Arizona. F. C. Roberts, Jr. Arizona Public Health News, No. 111, May 1935. From material furnished by Agricultural Experiment Station at University of Arizona, hardness of 155 rural and municipal water supplies has been computed. Results are summarized as follows: average carbonate hardness, as $CaCO_3$, 161 p.p.m.; average total hardness, 258 p.p.m. It would seem from this that softening of our water supplies is an important problem. In some isolated districts the only water available is hard. One of these has total hardness of 1267 p.p.m.—*G. C. Houser.*

New Sanitary Engineering Laws. Monthly Bulletin, Indiana Division of Public Health, 38: 5, 67, May 1935. Public water supply requirements demand increasingly greater degree of treatment of sewage before it is discharged into our streams. The 1935 legislature passed an act granting Department of Commerce and Industry control over pollution of any waters of Indiana, with power to make determinations, orders, and regulations governing same, and prescribing powers and duties of such department. Act prohibits pollution of any waters of the state. It provides for the raising of funds by municipal corporations to comply with orders of the department and provides penalties for violation thereof.—*G. C. Houser.*

Water Purification in Pennsylvania. H. E. Moses. Pennsylvania's Health, 13: 3, 23, May–June 1935. At end of 1930, Pennsylvania had population of 9,631,350, of which more than 6 million used water both filtered and chlorinated and over 2 million used chlorinated water, not needing filtration at this time, a total of more than 8 million people, or 80 percent of citizens of Pa. Extension of such safe water to greater numbers year by year is coincident with constantly decreasing typhoid fever rate and unquestionably has been an important factor in this decline. There are 28 water softening plants in Pa., mostly west of the Alleghenies. In 1906 there were 3917 deaths resulting from typhoid fever, a rate of 54.8 per 100,000 population. In 1934 there were only 125 deaths, equivalent to a rate of 1.3 per 100,000: a reduction of approximately 97 percent.—*G. C. Houser.*

Many Ohio Municipalities Soften Water Supplies. Ohio Health News, **11:** 13, 4, July 1 1935. Municipal water softening plants in Ohio now number 58. Seven new plants were completed recently and put in operation, 5 of them financed under P.W.A. Reading, Grafton, and Canal Winchester have installed lime-soda plants: New Philadelphia, Worthington, and Elmore have adopted zeolite softening. At the Elmore plant, sodium hydroxide and sodium silicate are added to the water after softening, to correct corrosive qualities. The Mt. Sterling softening plant combines aëration and lime treatment.—*G. C. Houser.*

Protection from Water Closet Cross Connections. F. C. ROBERTS, JR. Arizona Public Health News, No. 113, July, 1935. Installation of flush valves for water closets in schools, hotels, theatres, office buildings, etc., has been a problem for many years. Sudden lowering of pressure in water supply system may cause back-siphonage from water closet through this type of valve. Probably the most satisfactory solution to this problem is to introduce a vacuum breaker between flush valve and bowl. Such an installation provides greater protection from this grave public-health menace, as illustrated in investigation of late amoebic dysentery epidemic in Chicago.—*G. C. Houser.*

Trends in State Sanitation. W. J. SCOTT. Connecticut Health Bulletin, **49:** 8, 188, August 1935. In 1798, first small public water supply in Connecticut was developed in Durham; but steady rapid growth in number of public supplies did not begin until about the time of Civil War. Now there are 102 public water supply systems in the state, supplying 141 communities representing about 1,500,000 people, or approximately 89 percent of population. Sanitary supervision of public water supplies has unquestionably helped to bring about rapid decline of typhoid fever in Conn. In 1934, for example, there were only 7 typhoid deaths in entire state, whereas typhoid rate prevalent 50 years ago would have taken toll of 564 deaths among our present population.—*G. C. Houser.*

The Value of Laboratory Tests for Water. W. H. KELLOGG. Weekly Bulletin, California Department of Public Health, **14:** 29, 113, August 17 1935. This article is designed to aid those who may for various reasons suspect safety of their water supply. If source is public water supply, consult your local health officer. If source is a well on your own premises, look to location of well with respect to privies, cesspools, and barns; if too close, move one or the other. Protect well from surface drainage. If well is possibly subject to sewage contamination from sources outside the family, write to State Department of Public Health. As a last resort, a special mailing container for samples will be sent.—*G. C. Houser.*

Health Promptly Safeguarded in the Muskingum Valley. Ohio Health News, **11:** 17, 1, September 1 1935. Prompt action was taken by State and local health authorities to safeguard public health during and after the flood which recently swept Muskingum Valley following torrential rains. Week of August

5 developed flood conditions which virtually duplicated disastrous flood of 1913 in same territory, except as to loss of life. There was much interruption to waterworks service, which could have been avoided if all communities affected by 1913 flood had heeded its lessons and established their water works and filtration plants at elevations above flood level. Waterworks at Coshocton, Millersburg, and Canal Fulton were chief sufferers by flooding. Coshocton service was discontinued for about 12 hours, and Millersburg was without water for 3 days.—*G. C. Houser.*

Public Health in Massachusetts in 1934. H. D. CHADWICK. The Commonhealth (Mass. Dept. of Public Health) **22**: 4, 199, Oct.–Nov.–Dec., 1935. If we go back in the records 25 years, we find that typhoid fever afflicted about 3500 persons a year and caused 400 deaths. Contrast that picture with last year, when there were only 135 cases in the whole State, with but 13 deaths. This item of progress in public health comes about to a large extent by improved sanitation. Public water supplies are free from sewage contamination and close supervision is maintained over them. Of the 355 cities and towns of the State, 241, with 97.3 percent of population, have public water supplies, and 121 have sewerage systems.—*G. C. Houser.*

The Significance of Ammonia for Chlorine Consumption of Water. M. L. KOSCHKIN and E. M. SPEKTOR. Zeitschrift für Hygiene und Infektionskrankheiten, **117**: 6, 742, February, 1936. (Sixth communication.) Substances of vegetable origin, such as hay, pine needle extract, unsaturated fatty acids, benzole derivates, phenol, salicylic acid, and amino-acids, such as glycocoll, alanine, leucine, show an appreciable chlorine consumption, which after preammoniation is markedly reduced. Saturated acids, such as palmitic acid, urea, glucose, and acetic acid do not fix chlorine at ordinary temperature. Inorganic matter, such as nitrites and copperas, show reduced chlorine consumption after preammoniation. Possibility, however, of identifying contaminating substances in accordance with variations in chlorine binding power after ammoniation is limited, due to complex composition of natural waters.—*Manz.*

The Procedures for Determination of Bacterium Coli in Water. R. HEY. Kleine Mitteilungen des Vereins für Wasser-, Boden-, und Lufthygiene, **12**: 1/4, 87, January 1936. Detailed description is given of standard practice adopted at the Prussian State Board for Water, Soil and Air Hygiene for determination and evaluation of *Bact. coli*. Two equal series of samples ranging from 100 ml. to 10 or to 0.0 ml., according to the extent of presumptive contamination, are incubated for 48 hours, the first at 37°, the second at 46°C. with one eighth glucose peptone broth. For 100-ml. samples, EIJKMAN fermentation flasks, for 20- and 10-ml. samples, DUNBAR tubes are used; to 10-ml. samples, 12.5 ml. of diluted broth, containing 2 percent glucose, 2 percent peptone, and 1 percent sodium chloride being added, so that tube size may be kept uniform. For further dilutions made from 0.5 ml. of the original sample and 49.5 ml. sterile tap water, DURHAM reagent tubes with small floating gas tubes and BULIR neutral-red mannite broth are preferred. Gas positive tubes

and 46° tubes showing turbidity without gas formation are transferred to Endo-lactose-fuchsin-agar plates for incubation at 37°C. in order to obtain pure cultures. Where only a small coli-like colony appears, inoculation is made into trypsine-broth at 37°C. for 4 to 6 hours. At this stage, form, gram staining, and motility of the strain are investigated. Pure strains obtained from Endo-plates or enrichment broth are confirmed by inoculation of a "colored series" mostly consisting of neutral-red-glucose-agar, glucose-litmus-nutrose-broth, lactose-litmus-nutrose-broth, litmus whey, neutral-red-mannite broth, and trypsine broth; as before, a duplicate series of each medium is incubated, the first at 37°C., the second at 46°C. In order to differentiate from colon-like liquefying organisms, nutrient gelatine tube, as used for gelatine count, is incubated several days at 22°C. From results of fermentation series, Coli-index, and in absence of *Bact. coli*, index of thermophilic organisms capable of growth in EIJKMAN broth, is indicated. Strains showing cultural characteristics in all media at 37° and 46°C. are recorded as typical *Bact. coli*; strains incapable of growth at 46°C., or otherwise lacking characteristics typical of *Bact. coli*, such as decolorization of neutral-red, are interpreted as atypical. For evaluation of *Bact. coli* by enumeration of colonies developed on solid selective media, lactose-fuchsin-gelatine plates according to BÜRGER are incubated for 4 to 5 days at 22°C.; for larger samples, a two and a half fold concentrated gelatine medium is used, 10 ml. of which are mixed with 15 ml. of sample.—*Manz*.

Experiments with Circulation Feed Water Purifier Dejector. A. FREDERKING. Die Wärme, **59**: 15, 263, April 1936. The so-called Dejector procedure tends to concentrate sludge precipitated inside the boiler by soda ash or phosphate in a separate vessel, by means of continuous circulation of boiler water, maintained by density difference of water in insulated inlet pipe from the boiler. Upper part of vessel contains necessary supply of chemical, which is gradually dissolved by a part of the returning water. Expensive softeners with complicated proportioning apparatus and accurate supervision of chemical dosage are unnecessary; excessive blow-down is avoided. Tests on small-sized installations showed sludge removal up to 99 percent, with adequate chemical dosage and circulation.—*Manz*.

Contribution to Determination of Gas-Producing Germs. HEINRICH THIELE. Archiv für Hygiene und Bakteriologie, **115**: 4/5, 257, January 1936. For large samples, graduated milk bottles with wide neck are conveniently used instead of DUNBAR tubes and are sterilized with cotton stopper with tinfoil underneath. For gas collection, sterile glass tubes of 20 mm. diameter, 120 mm. length, and approximately 30 cc. capacity are prepared. Bottles are filled in usual manner with sample and nutrient broth, tube with open end downwards inserted by means of sterile forceps, the stoppered bottle inverted to release enclosed air from tube and again righted, and, after removal of tinfoil, incubated as usual.—*Manz*.

As to Sanitary Interpretation of Chlorinated Swimming Pool Waters. E. REMY. Archiv für Hygiene und Bakteriologie, **115**: 4/5, 181, January 1936.

(Cf. former communication.) Results of regular chemical examination of pool water during operating period give no index of contamination if chlorinated water is entering the pool. Total solids, chlorides, permanganate consumption and ammonia content increase steadily at first after complete refilling; then when chlorinated fresh water is applied, a lag occurs, followed by further increase to a maximum, after which a decrease sets in, giving no indication of time when another change of water becomes necessary. With residual chlorine ranging from 0.17 to 0.41 p.p.m., absence of *Bact. coli*, but high bacterial counts, steadily increasing up to 96,000 per cc., were observed. Frequent checking of iron and copper content is recommended, in order to detect corrosive action of chlorinated water on pipes.—*Manz.*

Determination of Dissolved Oxygen in Water by Winkler's Method. P. Sander. Kleine Mitteilungen des Vereines für Wasser-, Boden- und Lufthygiene, **11**: 5/8, 189, May 1935. Instead of dissolved reagents, as used in conventional procedure, dry chemicals in form of tablets (1.5 grams of compressed anhydrous manganous chloride and potassium hydroxide "in rotulis") are especially suitable for fixation of oxygen in field work. Volume correction is applied. Results are as accurate over the entire range as with solutions.—*Manz.*

Investigations on Reactions Occurring in Steam Boilers. Heinrich Riemer. Mitteilungen des Technischen Versuchsamtes, **24**: 52, 1935. Thermal dissociation of sodium carbonate in boiler water was believed to be exclusively dependent on operating pressure; but by occasional observations and systematical investigations, with careful sampling of boiler water, decomposition of carbonate has been proved to be also a function of the percentage rating of the boiler, being increased with higher ratings at the same pressure. At the relatively low pressure of 85.3 pounds per square inch, 82.6 percent was converted to caustic soda. Rate of decomposition is in relation to rate of steaming; at 180°C., decomposition after one minute was practically complete. As the resultant sodium hydroxide does not prevent deposition of calcium sulfate, or silicates, serviceability of soda ash for boiler water conditioning is limited; for higher ratings as well as for high boiler pressures, use of phosphate is recommended.—*Manz.*

Determination of Iodine in Drinking and Mineral Waters. Fritz Sander. Archiv für Hygiene und Bakteriologie, **115**: 6, 346, March 1935. Nitrites interfere with determination of iodine after oxidation with potassium permanganate, remaining unchanged and reacting then like iodate with potassium iodide and starch; after oxidation with permanganate, nitrites are to be destroyed by urea.—*Manz.*

Step-Photometric Determination of Free Chlorine in Chlorinated Water. L. Goldenberg. Mikrochemie, **18**: 2, 235, 1935. To 100-ml. sample, 5 ml. *o*-tolidine reagent, 2 ml. sulfuric acid, and distilled water to 110 ml. are added and solution is tested with Pulfrich-photometer. With 50-mm. layer, 0.0259 p.p.m. free chlorine is easily detectable. Maximum colour is reached after

several minutes and remains unchanged for approximately 20 minutes. Interference of ferric iron is eliminated by immediate addition of 2 ml. sulfuric acid 1:4 following *o*-tolidine reagent; this does not affect the development of chlorine-tolidine-colour, but minimizes the effect of iron and nitrites. Presence of nitrites is marked by deepening of colour after exposure to stage-lamp. Interference by manganic salts is prevented by reduction according to Adams and Buswell procedure, modified by use of 1 percent hydrogen peroxide solution, and *o*-tolidine reagent after 5 minutes.—*Manz.*

Method of Determination of Traces of Heavy Metals in Mineral Waters. K. Heller, G. Kuhla und F. Machek. Mikrochemie, **18**: 2, 193, 1935. Ratio of Co, Ni, Sn, Pb, and Zn in mineral waters gives information relative to their geological origin. Owing to limited applicability of spectrographic investigation without preceding chemical separation, methods for quantitative enrichment and determination of traces of metals were tested. For separation from alkali and alkaline earth salts, extraction of diphenylthiocarbazone or pyridine-thiocyanate compounds of minimum solubility in water, but of great solubility in organic solvents such as carbon tetrachloride and chloroform is availed of and the extract is further tested by polarographic method of Heyrovsky. With small amounts of solution, repeated current-voltage-curves are plotted, which may be photographed; these curves show definite characteristics which render possible the qualitative and quantitative evaluation of the metals present.—*Manz.*

Treatment of Extremely Soft Surface Waters. L. W. Haase. Gesundheits-Ingenieur, **59**: 3, 41, 18, January 1936. In order to develop a natural protective coating of calcium carbonate, pH adjustment and a minimum calcium carbonate content of 35.7 p.p.m. are necessary. For water with less calcium carbonate and with low carbon dioxide content, suitable choice of treatment becomes advisable. For the alum coagulation, to remove colour, or turbidity, sodium carbonate, and not lime or magnesia, is indicated for pH adjustment purposes in order to furnish additional free carbon dioxide which may be subsequently combined with lime or marble to provide the desired calcium carbonate hardness. Experiences with an impounded water of 12.5 p.p.m. calcium carbonate content are reported: after dosage with lime, pipe corrosion decreased, but not sufficiently so; coagulation with alum and sodium carbonate, with subsequent lime treatment, resulted in better flocculation and increased calcium carbonate hardness of 34 p.p.m.; iron content of tap water decreased from 25 to 0.1 p.p.m.—*Manz.*

A Selenium Spring. John T. Miller and Horace G. Byers. Ind. Eng. Chem., News Ed., **13**: 23, 456, 1935. Temporary spring in Custer Co., S. D., was alleged to have caused death of cattle drinking the water. Selenium content of water was only 0.4 p.p.m.; but that of surrounding soil, from 1 to 4 p.p.m., and of nearby vegetation, from 4 to 1610 p.p.m. Water consumed is believed to increase toxicity of vegetation by extracting soluble selenium compounds, and not to act as primary toxic agent. Lethal dose of selenium is believed to be two mg. per animal pound, that of arsenic being approximately ten times as great.—*Selma Gottlieb.*

Areametric Analysis. A Useful Technique in Estimating Small Amounts of Heavy Precipitates. V. R. DAMERELL and M. AXELROD. Jour. Am. Chem. Soc., 57: 12, 2724–5, 1935. Small amounts (0.01 to 5 mg.) of lead sulfate or other heavy precipitates are estimated by producing small compact piles of precipitate by special manipulation of reaction flask, and comparing with "standard spot" card calibrated against known amount of precipitate.—*Selma Gottlieb.*

Synthetic Resins for Base Exchange Process of Water Treatment. C. H. S. TUPHOLME. Ind. Eng. Chem., News Ed., 14: 1, 3, 1936. Certain tannin-formaldehyde resins have base exchange properties for many cations, including calcium and magnesium. Pounds of lime removed per 100 pounds of material is of same degree of magnitude for resin and zeolite. Also, certain resins prepared from aromatic bases, e.g., aniline with *m*-phenylenediamine, will remove anions from solutions of acids or their salts. By treating city water first with tannin resin and then with aniline resin, dissolved solids were reduced from ca. 330 p.p.m. to ca. 10 p.p.m. Same process carried out two or three times removes most of salt from sea water. Possibilities of large scale development and potability of product have not been investigated.—*Selma Gottlieb.*

Effect of Mixed Acid upon Iron and Steels. JUSTICE EDDY and F. A. ROHRMAN. Ind. Eng. Chem., 28: 1, 30–1, 1936. Contrary to effect in dilute acid solutions, mixture of 40 per cent sulfuric acid, 40 percent nitric acid, and 20 percent water acts more rapidly on low-carbon than on high-carbon steels. In low-alloy steels, all alloying elements tested, except manganese and sulfur, increased resistance of metal to corrosion. Quenched steels retain more passive surface than do furnace-cooled steels.—*Selma Gottlieb.*

Removal of Silica from Solution at Boiler Temperature. FREDERICK G. STRAUB. Ind. Eng. Chem., 28: 1, 36–7, 1936. In presence of excess magnesium oxide, silica content of boiler water fell to 6 p.p.m., even in presence of 1800 p.p.m. of sodium hydroxide. When sodium aluminate was present in addition, silica was reduced to 1.8 p.p.m. Neither reaction is affected by sulfate from 144 to 663 p.p.m. or by chloride from 53 to 106 p.p.m. Temperatures studied were 182 to 282°C.—*Selma Gottlieb.*

Analcite. FREDERICK G. STRAUB. Ind. Eng. Chem., 28: 1, 113–4, 1936. Crystals of analcite, $Na_2O \cdot Al_2O_3 \cdot 4SiO_2 \cdot 2H_2O$, a scale-forming material found in boilers, were prepared at 282°C. and subjected to petrographic examination and chemical analysis. Solubility was determined at 182° to 282°C. in water alone and in presence of sodium hydroxide concentrations up to 140 p.p.m. Results indicate that if silica in boiler is kept below 120 p.p.m., formation of analcite scale can be prevented.—*Selma Gottlieb.*

A Method of Analysis for Fluoride. W. M. HOSKINS and C. A. FERRIS. Ind. Eng. Chem., Anal. Ed., 8: 1, 6–9, 1936. In estimation of fluoride by titration with standard thorium solution, sodium alizarin sulfonate indicator is best used in concentration of 4×10^{-5} percent in total volume of 50 cc. Solution in 50 percent alcohol is titrated to match blank at very light pink shade,

both being buffered at pH 3.5 with sodium hydroxide and monochloracetic acid. Average accuracy of 99 percent was obtained with 57 to 760γ of fluorine, and same accuracy in 5-cc. volume with 6 to 90γ of fluorine. Sulfate interferes, but is left behind in distillation. Application to spray residues is discussed.—*Selma Gottlieb.*

Organic Inhibitors of Corrosion. Aliphatic Amines. Charles A. Mann, Byron E. Lauer and Clifford T. Hultin. Ind. Eng. Chem., 28: 2, 159–63, 1936. Contrary to previous statements concerning aliphatic amines, *n*-tributylamine (I), *n*-diamylamine (II) and *n*-triamylamine (III) are excellent inhibitors of acid corrosion of steel. Concentration of 0.66 percent of I in normal sulfuric acid decreased corrosion of mild steel 97 percent; of 0.34 percent of II, 98 percent; and of 0.13 percent of III, 99 percent. Stereochemical structure of compound determines cross-sectional area parallel to metal surface occupied on adsorption and is therefore a determining factor in effectiveness of inhibitor, though phenomenon is not thoroughly understood.—*Selma Gottlieb.*

Gaskets. F. C. Thorn. Ind. Eng. Chem., 28: 2, 164–70, 1936. Gasketed joints are classified as to types and as to materials of construction suitable for various uses and for various fluids, including water, steam, etc. Tentative formulas are offered for design of flat flange joints. Prefabricated rubber gaskets are mentioned for use with plain-end pipe or with modified bell-and-spigot joints for cast iron pipe.—*Selma Gottlieb.*

Wood Tanks. Charles R. Harte, Jr. Ind. Eng. Chem., 28: 2, 176–9, 1936. Construction and use of wooden tanks are described. Of 117,000 wood tanks in commercial use in United States, 40,000 are water tanks in gravity sprinkler systems and water supplies, with value of \$20,000,000. Initial cost and maintenance of properly assembled wood tanks are low; rate of depreciation depends on use.—*Selma Gottlieb.*

Drying Gel Zeolites. M. G. Larian and Charles A. Mann. Ind. Eng. Chem., 28: 2, 196–200, 1936. Proper drying was judged from percentage of fine material obtained on hydration after drying, and by base exchange value of dried product. Relation of dry-bulb temperature to relative humidity must be properly adjusted, and material must not be over-dried. Very rapidly dried material showed pronounced case-hardening and powdering and decreased base exchange capacity, latter due to constriction or possibly complete closure of surface capillaries. With increasing percentage of aluminate, base exchange capacity of zeolite increases to certain point, and then decreases. However, higher cost and lower mechanical strength of high-aluminate zeolites are limiting factor. Hydration depends to some extent on conditions of drying, but is independent of composition of zeolite.—*Selma Gottlieb.*

NEW BOOKS

Sixty-Ninth Annual Report of the Commissioners of Water Works in the City of Erie, Pennsylvania, for Year Ending December 31, 1935. 72 pp. Usual exceptionally complete operating and financial statistics are given in tabular

form. Statement of profit and loss shows net deduction from surplus of \$11,736.38. Daily average consumption by estimated population of 120,000 was 21.88 m.g., per capita consumption being 182.32 and 108.35, inclusive and exclusive of metered industrial and commercial use, respectively. Cost of collecting, purifying, and delivering water, including depreciation, was \$34.896 per m.g. Number of gallons of water pumped per pound of coal used averaged 359.80. Water to value of \$60,256.46 was supplied without cost for municipal purposes. Plant operating data show, for Chestnut Street and West filter plants, respectively, following amounts of chemicals and wash water used: alum, 0.211 and 0.229 grain per gallon; chlorine, 1.68 and 1.68 pounds per m.g.; ammonia (Chestnut Street only) 1.03 pounds per m.g.; wash water, 2.77 and 1.18 percent of water filtered. Analytical data include monthly average bacterial count, turbidity, alkalinity, and color of raw and filtered water, average temperature, and results of *B. coli* tests. Latter were consistently negative in 10 and 1 cc. on filter effluents throughout year. Brief description of works and schedule of water rates is appended. New completely automatic high service booster pumping station was placed in service during year.—*R. E. Thompson.*

Sewage Chlorination Studies. William Rudolfs and Harry W. Gehm. New Jersey Agricultural Experiment Station, New Brunswick, N. J. Bulletin **601.** 72 pp. March 1936. This Bulletin reports upon some masterly research, of absorbing interest and outstanding importance. When it is remembered that almost invariably the sole, or main, object of chlorinating water supplies is to chlorinate the fraction, greater or less, actual or potential, of sewage which may be present therein, its significance in this connection will be appreciated. Part I, pp. 3–30, is devoted to chlorine consumption. It is explained that this has been determined throughout by the *o*-tolidin test under certain specified conditions and at room temperature. It will usually include, therefore, so much and only so much of the chlorine as has lost its power to react with *o*-tolidine; in other words, which has been reduced; it will rarely include chlorine which has entered into compounds of chloramine type. The various fractions into which domestic sewage may, on the basis of their different degrees of dispersion, be divided, the chief individual soluble compounds known to be present therein, and sundry other bodies frequently present in sewage have been systematically studied both as to the amounts of chlorine which they consume and as to the rate at which the reaction proceeds. From the mass of interesting material presented, the following examples may serve as specimens. Of the urine compounds, uric acid is notable for its high chlorine demand and urea, rather unexpectedly, for having no demand at all. Sulphur compounds and unsaturated carbon linkages stand out as important consumers of chlorine, while the demand of carbohydrates and of fatty acids and hydroxy-acids is negligible. Amino-acids and proteins occupy an intermediate position. Lignin absorbs rapidly a considerable amount of chlorine, most of which it again slowly releases. The finely-divided suspended solids absorb more chlorine than any other fraction. Chlorination markedly influences the degree of dispersion and brings into solution a considerable quantity of nitrogenous material. Part II, pp. 30–49, deals with extensive investigations into the bactericidal

and other related properties of chlorination. Part III, pp. 49–55, treats of the influence of certain physical and chemical factors upon the bactericidal action of chlorine. Temperature, agitation, chlorine concentration, and presence of hydrogen sulfide are chiefly considered. Part IV, pp. 55–65, discusses the effect of chlorine on oxidation. Pp. 65–69 are given to a General Discussion; pp. 69–71 to a Summary; and pp. 71–2 to the bibliography of 44 references. Excellent tables and graphs are found throughout.—*Frank Hannan.*

Selected Papers, Tenth Annual West Virginia Conference on Water Purification, October 31–November 1, 1935. West Virginia University Bulletin No. **16-I**, April 15, 1936. 6 x 9 inches. 134 pages. **Quality Versus Quantity of a Public Water Supply.** PERKINS BOYNTON. 5–7. Public interest in water works, originally principally concerned with adequate provision for quantity, now demands much in respect to quality. **Practical Application of Activated Carbon for Taste and Odor Control.** F. E. STUART. 8–15. Removal of tastes and odors can most generally be accomplished by pre-chlorination, the addition of activated carbon as split treatment, a small dose in the mixing tank and a second larger dose preliminary to filtration, followed by filtration at a low rate with the addition of chlorine ammonia treatment after filtration. Practical results are recorded. **Unusual Difficulties in Treating Mine Waters.** W. E. HOLY. 16–18. Oak Hill, West Virginia, water supply is taken from a mine. Iron and hardness are reduced by aëration and lime treatment; but treated water still carries sodium sulphate to the extent of 650 p.p.m. **A Procedure for Determining the Necessary Treatment to Prevent Corrosion.** P. L. MCLAUGHLIN. 19–28. Simple tests determine pH of calcium carbonate saturation, to be used as a guide for the application of lime. **Lime Treatment of Well Waters.** M. E. FLENTJE. 29–40. Soft well waters of low alkalinity and corrosive to iron and steel pipe can be stabilized after filtration by addition of lime. Care must be taken to maintain proper balance to prevent lime turbidity at consumers' taps. **Ohio River Water in the Wheeling District and Its Treatment for Use in Boilers.** W. W. HODGE, E. J. NIEHAUS. 41–66. Total rainfall in 1934 in Wheeling industrial district was 14 percent less than general average. Ohio River was acid for 48 consecutive days during summer of 1934. Acidity is thought to have been caused by mill wastes and mine drainage, insufficiently diluted by shrunken stream flow. Foaming difficulties experienced by railroads may be due to organic load of Ohio River. Experimental study of one-m.g.d. lime soda plant resulted in plant improvements and better product. **Improving Public Water Supplies with P.W.A. Funds.** M. L. O'NEALE. 67–71. Summary of P.W.A. activities in West Virginia. **The Development of Water Bacteriologically.** G. L. KELSO. 72–76. Four phases are discerned; (1) work prior to development of bacteriological technique; (2) discovery of significance of bacteria and determination of number and kinds present in water; (3) use of index organisms; and (4) modern trends in improving technique and shortening time of operations. **Recent Developments in the Chlorine Ammonia Process.** H. A. FABER. 77–83. Where water to be sterilized is without taste, or polluting substances with which chlorine reacts to produce taste, and conditions such that a persistent residual is not required, chlorine alone is effective. The

ammonia-chlorine process is appropriate where conditions require a long persistent residual and where quick sterilization is not a factor. The chlorine-ammonia process is effective in water having tastes which can be combated by heavy chlorination, which is followed by dechlorination with activated carbon and final post-chlorination and ammoniation treatment. **Operating Small Water Plant**. C. VANDEN BERG, JR. 84–89. Practical experience in improving the efficiency and service of small plants. **Springs of West Virginia.** P. H. PRICE, JOHN B. MCCUE, H. A. HOSKINS. 90–125. Report of State Geological Survey covers rates of flow, temperatures, chemical analyses, geologic origins, and histories of development of over 50 natural springs. **Water Pollution Control in West Virginia.** E. S. TISDALE. Public attitude favors cleaning up of streams. Sewer rental acts make possible financing of sewerage and sewage disposal systems. Rural sanitation has greatly improved conditions on small streams. Program of controlling acid mine drainage has been successful. Storage projects of the Ohio River Basin Flood Control Program will benefit Monongahela and Kanawha Rivers, alleviating troublesome stream pollution. Coöperation of National Resources Board has been helpful.—*R. L. McNamee.*

Droughts of 1930–1934. JOHN C. HOYT, Consulting Hydraulic Engineer, U. S. Geological Survey, Washington, D. C. Geological Survey Water-Supply Paper 680, United States Department of the Interior. Paper 6 x 9 in.; pp. 106; tables and line cuts. In this paper the author presents very interesting and valuable information relative to droughts which occurred in the United States in 1930–1934. As to the scope of the paper, the writer cannot do better than quote the following from the introduction of the author: "Drought conditions during these years are of more than academic interest. They stand out as a limiting basis in the availability of surface and ground waters in works involving many millions of capital outlay. If future water supplies are to be unfailing, sufficient storage must be provided to withstand the recurrence of similar shortages at any time. This report summarizes, as an aid to the more detailed analyses that will arise in the consideration of specific projects, some of the more outstanding questions related to droughts, both physical and economic. It outlines the nature and extent of the droughts of 1930–34; compares them with past dry periods in terms of precipitation, run-off, ground water, evaporation, and transpiration; and sketches the effects of droughts on water supplies as related to a variety of human purposes, including agriculture, domestic and industrial uses, health, power, navigation, and recreation and wild life; it also touches upon the relief, political, and economic elements." Throughout the paper the author shows his intimate familiarity with the subject of drought conditions, and those who may be interested in such conditions will be well repaid for the time spent in reading this paper. As this brief review is written for a water supply journal, it may perhaps be proper to state that the report does not give detailed information and figures which would be needed by the engineer interested in estimating the amount of storage required for water supply purposes or for the generation of power. The report is replete with tables and diagrams relating to rainfall and drought conditions. One table is of especial interest in that it gives the annual precipitation in inches, by states, for the years 1881–1934, inclusive.—*John H. Gregory.*

ERRATA

VOL. 28, NO. 8, AUGUST, 1936

The item in the Table of Contents listed as:

Statement of General Policy Committee........................ 1068

should read—

Report of the Committee on National Water Policy............ 1068

The Report of the General Policy Committee is published in this issue (September), page 1422.